EYE PATHOLOGY LECTURES OF DR. TERRY

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Lid and Conjunctiva

Normal lid-

The skin of the lid is very loosely attached and contains a few hairs. It is probably as thin as any skin of the body. On the inner side conversely, the mucous membrane is firmly attached to the tarsus.

Early in life the mucous membrane is quite smooth but later due to irritation follicles develop which are simple lymphoid follicles. Diverticula which resemble glands also develop. These are referred to as the ww glands.

Lid margin- composed of cilia, Zeiss glands, and Moll's glands, and further back are the Meibomian glands. The sebaceous material that comes from these glands seals the lids making them water tight.

The tarsus is very dense fibrous tissue in which the Meibomian glands are embedded.

Muscles- orbicularis oculi, levator palpebrae, superioris. Also, the superior and inferior tarsal muscles or the muscles of Mueller. Above, the superior muscle connects the levator palpebrae superioris with the tarsus and with the orbicularis.

Mueller's muscle is smooth muscle and is supplied by sympathetic nerves. If you drop cocaine into the conjunctiva it makes the eye open wider by contraction of this muscle. This widening of the fissure tends to make the person appear exophthalmic.

There is a vestigial structure in the human consisting of smooth muscle. This structure, in lower animals pushes the eye out of the orbit. If the cervical sympathetic is stimulated this structure pushes the eye out and gives an exophthalmos.

Pituitrin and adrenalin given over a period of time results in an exophthalmos.

As this is connected up with the sympathetic system, we may conclude that in the human exophthalmos may be due in some instances to overaction of the vestigial structure which is stimulated by over production of thyroxin.

Molluscum Contagiosum

This is a small round umbilicated nodule of the skin surface. It contains sebaceous like material which is homogeneous in appearance and stains with eosin. If you stain with Giemsa you will find inclusion bodies. Thus, it is thought that the inclusion bodies are the cause of this conditions just as in psittacosis and inclusion blenorrhea.

Treatment-

Remove.

Milium

This is a retention cyst of the eyelid formed by the sebaceous glands. It appears somewhat like xantholasma.

Treatment-

Removal.

Xantholasma

This occurs frequently in the female and is thought to be in association with the menopause, or in association with ovarian dysfunction. In this condition pigment and giant cells are found. Do not confuse with pseudo-xanthoma elasticum with this disease as this is associated with angioid streaks.

Blepharochalasis

This is a rather rare condition occurring usually in young people. It follows almost always a recurring condition of marked edema of the eyelid. We see something that looks like this in many older people when the eyelids are dropped way down but it is not this disease.

The eyelid is stretched while the swelling increases. Following these attacks, the lid hangs down and the surface is covered by numerous fine wrinkles.

Microscopically we find a number of new capillaries and a proliferation of the endothelium.

Work of Alvis

Reference- Trans. A.M.A. Sect. of Ophth. 1934 and A.J.O. Series 3, Vol. 18, p.238, 1935

This is the last paper that reviews the literature on this condition. Alvis mentions that a differential diagnosis must be made between other conditions.

Paraffinoma

This is a tumor produced by paraffin or oil. It was more common in the past because paraffin of low melting point was frequently injected for cosmetic purposes. If the patient had a fever the paraffin would melt and then form lumps. Also, antiseptic or radioöpaque oil has been injected into the lacrymal sac. It may break through the sac to infiltrate the surrounding tissue especially if much pressure is used. This appears as a granulomatous condition and looks somewhat like tuberculosis because of giant cell formation.

Hordeolum or Sty

This can affect the Zeiss glands (anterior sty) or the Mebibomian glands (posterior sty). The infection is usually staphylococcus.

Treatment-

Increasing the vital resistance sometimes helps.

Reducing carbohydrate intake in some cases.

Can use bacterophage.

Some patients seem to keep on having stys in spite of everything you do for them but often you find as they grow older the frequency of occurrence decreases and eventually the stys disappear.

Cases should not be treated too lightly during the course of the inflammation because cavernous sinus thrombosis and death have resulted.

Chalazion

This is an involvement of the Meibomian glands produced by blockage and probably infection. The wall of the cyst is often broken down and the sebaceous material seeps out. This produces a reaction that is like tuberculosis and like paraffinoma. However, chalazion must be differentiated from sarcoma of the lid. Therefore if you have a tumor of the eyelid called a chalazion of peculiar appearance get a microscopic examination of some of the tissue.

Treatment- complete removal. Dr. Greenwood puts in the tip of the actual cautery and lifts it out. Dr. Terry- incises with a local anaesthesia, cleans it out thoroughly with curretting.

Blepharitis

There are two types of this condition (1) squamosa type- analagous to dandruff (2) ulcerative-eczema. This may be an allergic condition and may precede hordeolum.

Treatment

1% or $\frac{1}{2}$ of 1% yellow oxide of mercury.

Reduce carbohydrate intake.

Acne Rosacea

This is a very common condition. See it in people exposed to extreme cold. Red nose and cheeks. May affect the eyelids or may even affect the conjunctiva or cornea. If you have an ulcer of the cornea and treat the rosacea the ulcer clears up. If the patient has acne rosacea of the face have to get the dermatologist to treat that.

Treatment-

Ointment 116- which has zinc oside and icthyol. This is good for cases of rosacea about the conjunctiva, lids, etc.

With injuries of the eyelid- if you can treat the patients rather promptly and join the edges of the cut tarsus the ultimate result will be better cosmetically. Try to keep the tarsal plate intact.

Diseases of the Conjunctiva

The conjunctiva differs from other tissue in the body because the temperature is lowest. There is relatively little blood supply. This may be the reason for getting infections of the eyelid that we do not see in other parts of the body.

Variable sensitivity of the conjunctiva-

holocaine- irritates some greatly and others not at all.

dust, smoke, and volatile irritants

hay fever, vernal catarrh

atropin, eserine

A skin test should be given for senstivity. The symptoms in mild chronic conjunctivitis cases are out of proportion to what you find when you examine the patient.

Concretions in the conjunctiva- small gland-like structures fill up with some material which insussates. Cut the top to expel the concretions and the patient will be more comfortable.

Sissons- Amer. Ophth. Soc. 1928

Hyperemia

The conjunctiva has no dilator nerves. It has only a vaso-constrictor. Dilation is brought about by an antidromic activity, through the sympathetic. Bayliss first describes this, and Brooks also worked on this. Duke Elder feels this is brought about

by a metabolism disturbance of the conjunctiva which produces this.

Loss of sleep, foreign body of the cornea, irritating air, etc. will give rise to hyperemia. All this we explain on the basis of antidromic activity.

Bacteria

Many saphrophytic bacteria are present in the conjunctiva. Lindner feels that these bacteria never give rise to any trouble because they are not epithelial parasites. However, Lindner says nothing of the catabolic process of saphrophytes giving rise to something that is irritant to the conjunctiva. He considers staphylococcus therefore as unable to produce conjunctivities.

Air bacillus or sarcina rarely give rise to conjunctivitis.

Pseudo-diptheria or xerosis does not give rise to conjunctivitis.

Staphylococcus, streptococcus, pneumococcus, subtilis, and coli, and inclusion bodies can and do give rise to conjunctivitis. The so-called rough form of pneumococcus, the uncapsulated form, may cause conjunctivitis.

Additional disturbances of the eye give rise to conjunctivitis such as chemical disturbances and volatile reagents- they may be enough to precipitate an acute attack.

Bacteriocidal agents of the conjunctival sac-

Tears- they protect the conjunctival sac by mechanical flow, increased flow with inflammation. The lysozone contents of the tear is rich but seems efficacious only against saphrophytes.

Sterilizing the Conjunctival Sac- we wish we could. Take smears and cultures to see if it is sterile. If you find pathogenic bacteria do not do an operation, as cataract extraction. Wash with boric acid. Some use potassium permanganate mercurial solution. Don't . . favor use of strong chemicals before operation. More value in repeated washing of the conjunctival sac. Also, be sure that the tear passage is not blocked. If find infection of the tear sac and you must operate, seal the puncta by actual cautery, or ligate the puncta- this seals off the infected tear sac.

Irrigations are of value but if you are too vigorous one may injure the tissue and get more bacteria.

Use of silver nitrate- this not only kills bacteria but also kills epithelial cells which must slough off. The white membrane caused by this drug is coagulation of epithelial cells.

Boric acid, saline, or sterile water are good as washes.

Keep out necrotic tags of tissue and blood after operation by thoroughly cleaning up the eye.

Bandaging- If the eye is covered 5-8 hours bacterial count is less.
If the eye is covered 12-14 hours bacterial count is greater.

Work of Thygeson-

Ref- Trans. A.M.A. 1934 and Arch. Ophth., Vol.12, p. 676, November 1934

Thygeson advocates two stains (1) Gram (2) Giemsa. The Gram stain differentiates many bacteria, and the Giemsa shows inclusion bodies and eosinophiles.

Material for making the smear- you can use the secretion. The more efficient smear is the epithelial scraping but if the patient is going to have an operation that day or the next day it is not a good idea to do a scraping. Also, if you have conjunctivitis coming from gonococcus it is not advisable ot do an epithelial scraping.

Culture material- Loeffler's blood serum agar. Chocolate and ascitic fluid agar are also helpful.

Non-Infectious Conjunctivitis-

Hay Fever- gives a conjunctivitis. If eyes are washed frequently or adrenalin injected into the conjunctiva the symptoms can be reduced. Also, estivin relieves some people that are not sensitive to it.

Vernal Catarrh- This is a follicular conjunctivits with large follicles which swell so that they press against other follicles so that it produces a six sided figure and gives a "pavement" appearance. The follicles in other kinds of conjunctivitispractically never have this cobblestone appearance. Also, there is hyperemia. Usually find a thin milky film over the conjunctival surface. If a smear is taken you will find it loaded with se eosinophiles. This is almost diagnostic of this condition.

Patients complain of this condition chiefly in the spring. Other times of the year they may have granulation tissue above the limbus and follicles but the eye is not inflamed. We find these patients are sensitive to most everything.

Treatment-

Washout the conjunctiva many times a day. Sodium bicarbonate wash is excellent. Also, saline. bandaging sometimes helps. Sometimes the condition seems serous enough to warrant the use of X ray or radium.

Rosacea-

Should be included in this classification. It accompanies rosacea of the skin. It is not a bacerial infection. If you find bacteria present they should be considered as secondary invaders.

Treatment-

Ointment 116

Reduce carbohydrate intake

Volatile Irritants.

Tear gas:

usually is chloracetophenone. If this is treated with prescription containing sodium sulphite, glycerin, and water.

Sodium sulphite .4

Glycerin 75.

Water 25.

This changes the tear gas into something that is not irritating.

Lime- also an irritatnt.

Treatment-

Neutral ammonium tartrate 5-10% freshly prepared. Use twice a day for one wekk or for one month.

Artificial silk manufacturers. Sodium solphuratic fumes.

Indelible poncil- in the eye.

Some of these poncils contain silver nitrate. Have to fight progressive irritation for several weeks or a month.

Treatment 10% tannic acid

Argyrosis-

From silver nitrate

Work of Weymann-

Ref. Trans. A?M.A. Sect. of Ophth. 1929 and
Jour. A.M.A. Vol.93, -p. 1367, 1929

Treatment- injection of 2?3 minims of the combination of sodium thiosulphite 10% with potassium ferricyanide 2% and it clears at the sight of the injection. But this treatment is very painful so we do not use it at the Infirmary.

Insect Bite-

Treatment- should get out the barb. Have to treat it for several weeks usually. If you find a bad localized conjunctivitis look for insect bite. It gives a reaction somewhat like that following piece of indelible pencil.

Catapillar Hairs-

Seems to cause a more toxic conjunctivitis than catapillar juice. Someone has experimented with this. Result is a tubercle formation around these hairs. This condition is referred to as ophthalmia nodosa. Also, ophthalmia nodosa reaction is sometimes found around sutures.

This reaction can be gotten from any sort of vegetable or animal hairs nto the tissue, or a cilium.

Powder burns- try to get out each particle of powder.

Eel's blood-

Oyster suckers- juice from oysters

Tar Workers- tar is a chemical irritant.

Bile- very irritating in the eye.

Coal and coke workers- sulphurous chemicals are released that are very irritating.

Hemorrhage- use ice until the hemorrhage is stopped, then use heat to absorb the hemorrhage.

Conjunctivitis - Infectious

Acute catarrhal

May be associated with coryza or chronic catarrh. Usually have mucous strands present in conjunctival sac. They may give sensation of foreign body. It is usually self-limited. After the nasal condition improves usually get over it. Also, have acute catarrh which may be contagious. This occurs particularly in young people. It runs a course of 6-7 days. It also may appear in the other eye.

Koch-Weeks bacilli forms long chains.

Streptococcus and pneumococcus will cause acute infectious conjunctivitis.

There is also a chronic conjunctivitis somewhat analagous to the acute. The bacteria may be the exciting cause but not the whole cause.

Treatment- 2.5 % saline solution as eye wash. This approaches sea water.

With this condition the symptoms are out of proportion to the evidence of disease.

Morax Axenfeldt- a contagious chronic conjunctivitis. It occurs at all ages.

Pseudo-membranous conjunctivitis- This may be a true diphtheritic membrane.

Treatment- it is best to make a smear and inject it into a guinea pig- make a smear and send it to the Board of Health to see if the organisms are pathogenic. Diptheria is very rare. However, if you have a case of true diphtheria it can be treated with antitoxin. Thygeson puts antitoxin in the conjunctival sac. One can also get a pseudo-membrane with a hemolytic strep.

Purulent Conjunctivitis

May have a variable amount of pus. This may be caused by gonococcus pneumococcus, streptococcus, and other organisms. Just because we have a purulent conjunctivits we should not say that it is gonococcus.

The conjunctivitis also may be secondary, and is in almost every instance where the tear passage is blocked. In every case of conjunctivitis see if the tear sac is open. If one takes a smear on rather young babies and finds a mixed infection one can be almost sure that the primary trouble is in the tear sac.

Also, can have a streptothrix blocking a canaliculus. This streptothrix does not block it completely. One can syringe through but without pressure of syringing passage is blocked. This is because the mass of organisms and debris lie in a diverticulum of the canaliculus wall and act as a "ball valve". Usually with this one finds a little point of tenderness and swelling alon g the canaliculus. Open from the outside and curette the cavity. If it is fairly near the eye pressure on it may express some of the material. It resembles wet newspaper. It is often advisable to take a smear or epithelial scraping, although ordinarily in purulent conjunctivitis one does not take an epithelial scraping but this depends on the type of infection. If it is gonococcus an epithelial scraping is more dangerous. Some purulent conjunctivitis is fairly mild. It is dangerous to the cornea and frequently gives rise to ulceration and perforation of the cornea, therefore, one should consider even a mild case as dangerous.

Gonorrheal Conjunctivitis

This may be due to "self infection" from urogenital infection or gotten from someone else. In cases, we associate it with the trauma of parturition. This is referred to as ophthalmia neonatorum. However, when the term "ophthalmia neonatorum" is used it does not always mean gonococcus.

Many of the babies that have ophthalmia neonatorum are premature.

Gonorrheal conjunctivitis is not as severe in new-born babies as its occurrence in later life, unless the person has a chronic gonorrhea. Patients that have chronic urethral gonorrhea seem to develop some general resistance. These patients may not have as severe a time as patients whose first gonorrheal infection is in the eye.

In severe purulent conjunctivitis cases have frequently swollen eyelids- so swollen that they can hardly see, chemosis of the conjunctiva, and copious discharge of pus. The conjunctiva is ballooned up with this pus and rests on the cornea. The gonococcus organism is ordinarily an epithelial parasite. Consequently, it will destroy the epithelium of the cornea and the toxic products and mixed infection will burrow through the cornea giving a perforation of the cornea.

Treatment-

Keep the eye clean. Wash as frequently as possible. Potassium permanganate, boric acid, most any chemical is all right as long as it is not too strong a solution. Irrigation should be done by someone who really knows how. Give as

often as necessary even up to every fifteen minutes. Usually it is needed at hourly intervals.

Put cold compresses to the eyelid when chemosis of the lids and conjunctiva is very great.

Some babies are born with pus streaming out of the eyes due to prolonged labor. The bacteria have gotten there during birth. Use some method so that the infection will not spread to the other eye.

Use of Buller's shield- make it water tight and put it over the good eye, after one is sure that the good eye is not affected.

Heat- puts temperature of the lids up therefore, if you have a great deal of chemosis do not apply heat.

Casten's method- does a canthotomy. Inverts the lid to relieve pressure from the cornea. Some patients are helped by this.

Conjunctival flap- if you see the epithelium of the cornea beginning to disappear you know that the cornea is infected. A conjunctival flap will sometimes save the eye. It is very good for prophylactic treatment also. Cut the conjunctiva off from all around the eye.

Milk- foreign proteins

Use of silver nitrate-

When the case is well on the way to being cured take silver nitrate, put it on . . with an applicator. The amount of dosage depends on the concentration of the silver nitrate and the amount of pressure applied. The more one puts on the deeper the necrosis will be. Put on just enough to get the surface epithelium off.

Inclusion Blenorrhea

Ophthalmia neonatorum can be an inclusion blenorrhea.

Inclusion blenorrhea is an infection of the conjunctiva giving rise to acute or chronic conjunctivitis and is usually associated with an enlarged pre-auricular gland. It never gives rise to blindness.

Thygeson Amer. Jour. Ophth. 1934

The Etiology of Inclusion Blenorrhea

Inclusions are of two forms- initial and elementary granules. The elementary granules get into the cell, develop to form initial body, and then break up to form elementary granules. The infection goes in this cycle. We do not know whether the inclusion bodies are bacteria or not. It is known that inclusion bodies are of a certain size because they will pass through only the Berkefeld filter with larger pores.

Inclusion bodies are associated with certain general diseases- vaccinia, rabies, fowl pox, encephalitis, psittacosis, and etc. These show acidophilic inclusion bodies whereas blenorrhea gives basophilic inclusion bodies.

If inclusions cause psittacosis and blenorrhea they probably cause trachoma also. Although, Nagouchi thought trachoma was caused by bacteria.

Finnoff and Thygeson experimented with prisoners. Found that they could carry trachoma infection with virus but could not carry it with Nagouchi's bacteria.

Inclusion blenorrhea in the new born or in children comes from a vaginitis- the genital system of the mother is infected, and the child is infected at birth. The conjunctivitis may resemble gonococcus in severity and copious discharge.

Thygeson has infected one of his own eyes with inclusion blenorrhea. In the adult it is usually referred to as swimming pool conjunctivitis and is a chronic thing. In children it is acute.

Treatment-

There is no particular treatment.

Be sure to differentiate this from trachoma- do this by seeing if the patient develpps a pannus. There is no chemical way to prove trachoma except the "pine tree test".

Lindner feels that trachoma and inclusion blenorrhea are first cousins. Also, he thinks that inclusion blenorrhea will protect the patient against trachoma.

Thygeson feels absolutely sure that one does not give protection against the other.

If a pserson has a mild urethritis and does not know he is infected one might prove this if inclusion bodies are found in the exudate. This is the person who contaminates the swimming pool.

Follicular disease is mixed up with swimming pool conjunctivitis and vernal catarrh.

For simple folliculosis can be cured frequently with zinc solphate.

In trachoma- follicles are formed the center of which is necrotic and also you find large mononuclear cells. In papillary form of trachoma you can have this also. Trachoma tends to involve the lids especially retrotarsally.

Use of zinc solphate- good if you just have a simple folliculosis.

Epidemic of conjunctivitis in the Clinic- investigated pilocarpin, eserine, etc. concluded the infection spread from a tonometer that had not been cleaned properly after use of a patient having this conjunctivitis.

Treatment for Trachoma-

Copper is the best treatment. Put copper stick on, and take it across the cornea pressing rather firmly.

Operation- to remove tarsal plate. Also, chalmooga oil, snow, heat etc. have been used ubt copper is the best.

Tularemia

Vail- Arch. Ophth., Vol. p.416, 1929

This occurs in people who handle rabbits. It has an incubation period from 1-10 days. Look up Vail's article. In the cases Vail reports the infection into the eye is the primary lesion.

Folliculosis

Irritative	Vernal	Inclusion	Trachoma
May be without symptoms	Irritation in the spring	Young-acute Older-chronic	Acute or Chronic
Tarsus	Tarsus	Tarsus and Retro-tarsal	Retrotarsal or Tarsal
_____	_____	May have pre-auricular gland enlargement	_____
Simple follicles	Cobblestone appearance	Follicles- may be confluent	Follicles can be "rolled" out
	Milky film Eosinophiles		Large monos
Lid only	Lid and near limbus	Conjunctiva	Lid cornea pannus
✗ remove cause or zinc sulphate	Frequent eye wash with sodium bicarbonate	Symptomatic	Copper
Prognosis good	good	good	blindness
Eti: Irritation Allergy Atropin Eserine	Allergic ?	Inclusion bodies from genital infection	Inclusions from other trachoma

Parinaud's Conjunctivitis

This is a very rare type of conjunctivitis described by Parinaud, many years ago. It consists in a granulating mass of tissue somewhat localized accompanied usually with a pre-auricular gland that is very large. This gland, however, never suppurates. The infection in some instances has been thought to be carried by cats.

Verhoeff found the picture of infection, necrotic material, inflammatory cells, and huge phagocytes. With all this he felt this condition must be an infection. This is not the picture of tuberculosis or a syphilitic infection but a chronic inflammation. Verhoeff used many kinds of stain. He varied the technique and finally found that with a modified Gram stain he could demonstrate a leptothrix. So this is really a letothricosis conjunctivae. He found that he could find the organisms in biopsy material of all typical cases. If you see this picture and the patient has also a large pre-auricular gland it is probably Parinaud's. It is rather a bad thing to have but eventually the patient gets over it.

Dr. King cultured the organism. He injected it into a laboratory animal and recovered the organism from it, thus fulfuilling the postulates.

Prognosis- can usually give a good one but must be sure it is a true leptothricosis disease. Differentiate from tuberculosis and syphilis, and a sporothrix infection.

Keratinization of the Conjunctiva

The conjunctiva being a mucous membrane never keratinizes normally. Keratinization gives a dry foamy appearance.

Causes:

(1) Vitamin deficiency

Give the patient butter, cream, and cod liver oil but sometimes this may not change the condition.

(2) Trachoma can cause this if the person has had trachoma for a long time.

(3) After the conjunctiva has been exposed to air for a long time-lagophthalmos.

(4) Presence of pemphigus

Pemphigus

With pemphigus the elastic tissue disappears, the conjunctival sac becomes small and the conjunctiva becomes hard and dry. The patient cannot turn the lid. The eye has a peculiar appearance that resembles a dead fish's eye. Have never seen pemphigus of the eye with blood vessels present.

To determine if the condition is pemphigus- take the blood serum and put it on the branches of a pine tree seedling. If the growth is retarded it indicates pemphigus or trachoma. This is called the "phytophaenologic" test.

Pinguecula

This occurs when the elastic fibers in the subconjunctival tissue, usually on the nasal side of the cornea, degenerates and gives a peculiar yellowish appearance. This term suggests a tumor of a fatty nature but the name was given when the change was thought to be fatty. When pinguecula starts you may not notice it for a while but if the patient has a hemorrhage under the pinguecula it stands out very vividly as a light yellowish "island" in the area of hemorrhage.

Pterygium

This often follows pinguecula. It is granulation tissue of the conjunctiva and a small amount of the subconjunctival tissue growing onto the cornea- this is true pterygium. Can put a probe almost completely under it. MacReynold's type of operation is used. Try to clean up the edges and get every bit off of the cornea. The operation should be done before the pterygium has extended into the pupillary area.

Hereditary Disturbance

Mendel's Law on dominant and recessive characteristics holds true but apparent variations from that are related to sexlinked characteris, allelomorphism, and other linkage of characters. Related characters depend on linkage of genes. Conditions which cause arrangement of genes to be changed produces mutations. Mutations have been produced by X rays on germ cells. Several hereditary characters are linked with the X and Y chromosomes in the human.- hemophylia, color blindness and etc. Colorblindness occurs in the female, however, when the characteristic is in the germplasm of both parents. That is, half of the daughters are colorblind where the father has colorboindness and the mother carries the factor. Mendelian characteristics of heredity are most simply shown by the algebraic multiplication as below.

D = dominant character; R = recessive character. Any linkage of DR takes the appearance of D.

Parents (multiply)	DD RR			
First generation (multiply)	DR DR		DR	All appear dominant
(summation of results)	DD	DR DR	RR	
Second Generation	1 DD	2 DR	1 RR	

1 pure dominant
2 hybrids- appear dominant
1 recessive
or 3 apparent dominants to 1 recessive

Genes- the study of genes makes up genetics.

X ray on genes-get a mutation. Believe that X ray will do this to the germplasm and the mutation caused will start a new race.

X and Y chromosomes are linked up with sex-i.e.color blindness, hemophilia, etc.- here you have the conidtion showing up in the male but carried by the female.

Allelomorph- this is connected with the sex chromosomes. Can take out certain portions of the embryo-

Ex- take a piece of tissue that is going to make the eye and put it in the leg you have a transparent skin over it.

Ex- taking optic vesiclefrom the embryo for corneal abrasion will make the tissue anterior to it transparent.

hereditary factors-

but makes up congenital defects-

Have three conditions- the perfect individual, the individual that has a tendency to disease, and the individual with bad environment.

The eyesshow more congenital defects than any other organ in the body. Ex- retinitis pigmentosa, colobomata, etc. if a congenital anomaly is a dominant factor.

Ex-recessive factor, albinism.

In order to draw satisfactory conclusions on hereditary factors in the human race would have to do 25% of the population for 2-3 generations.

Embryology and Congenital Anomalies

Congenital Anomalies

Symblepharon, ablyeblepharon, epicanthus, crystophthalmia, cyclopean-

Embryologic Basis of Cyclops- Adelmann see Trans. Assoc. for Research in Ophth., p.8, 1934. ectropion, entropion, trachemses, epitarsus, ptoses.

Embryology

1. Neural groove of the embryo is formed simultaneous with formation of optic depression.

The neural groove is converted into the neural tube and the cells start to differentiate into the cells to form the nerve system.

Figure 1 - The optic depression is converted into the primary optic vesicle. Then, there is a thickening of the ectoderm and invagination of the primary optic vesicle to form the secondary optic vesicle. Figure 2.

2. Lens vesicle- a diverticulum of ectoderm which thickenes, and invaginates then is cut off giving the lens vesicle. The center of the lens represents the surface of the body. The cells on the posterior surface longthen and proliferate to fill the vesicle. The older cells finally lose contact with the surface of the lens, condense and keratinize to form the lens nucleus. The arrangement of the lens fibers results in the Y and inverted Y and later the so-called lens star. The capsule of the lens is the basement membrane of the epithelium. The anterior capsule does not normally proliferate. Figure 3.

If you have a cataract that involves the lens just around the nucleus you can be sure that the cataract was formed when the child was in-utero.

3. Retina- That tissue which is going to be the retina is invaginated and the rods and cones are farthest away from the vitreous, so we really see with the back of the retina. The rods and cones are nearest the pigment epithelial layer of the retina. A space is present all during life and extends from the nerve head to the ora serrata. When we get a chorioretinitis it destroys a potential space. At the

ora serrata the two layers are fused giving the back of the iris and forming part of the sphincter and the dilatator pupillae. Figure 2.

4. How do nerve fibers from the retina get back into the brain? This is taken care of very neatly. The optic vesicle is incomplete all the way around. It has a foetal fissure. This foetal fissure gives access to mesoderm and blood vessels, the hyaloid artery. When this fissure starts to fuse it starts in the center and when the fusion spreads back it pushes the hyaloid artery back into the nerve several centimeters. This gives a core of tissue along which nerve fibers can grow from the retina to the brain. When the optic fissure fails to fuse a coloboma occurs.

Failure of Foetal Formation Gives the Following-

Undifferentiated retinal cells look like the cells in a retinoblastoma or glioma of the retina. Therefore, we conclude that glioma of the retina is embryonic tissue. This usually occurs in both eyes.

There is no hyaloid vein and the blood goes from the tunica vasculosa lentis out through vessels at the periphery of the embryonic lens.

As the eye grows in size more rapidly than the lens, the lens is no longer in contact with the ciliary processes and the zonular fibers which are adherent from the lens to the iris stretch back also. If you have a reniform shape of the lens a coloboma of the lens has occurred. This is due to the fact that no zonular fibers are developed on the lens at that point.

Coloboma of the retina-

The retina is reduced to 2-3 layers of glial tissue. At the edge of the choroid the layers are piled up giving a black edge to the shite coloboma. This affects the nerve head because the nerve has the central retinal vessel. The coloboma can extend over the macula but this usually involves the nerve down and in. If this involves the iris we have a coloboma of the iris. This coloboma of the iris may or may not be bilateral and may or may not involve the vision.

Coloboma of the Choroid-

If the fissure does not fuse and is very weak the eye may become a microphthalmic eye. There is a herniation of the tissue out and the sclera is not strong enough to withstand the intraocular pressure.

If you have a congenital microphthalmos you may have a cyst in the orbit. When a person has one sort of a congenital disturbance he frequently has others.

Work of Male-

He has done much work on pigs. He knew the heredity of these pigs for 17 generations in the female and for 9 generations in the male. He was working on vitamin deficiency. He deprived them of a certain vitamin for a long time. The litter showed many disturbances. Some had no eyes at all.

Congenital disturbances are important clinically.

Persistent fibro-vascular sheath on the back of the lens with hyaloid artery. The eye was removed for retinoblastoma. The hyaloid artery was carrying blood. The anterior capsular epithelium was growing all around the lens. Frequently, we do see spots on the lens where the hyaloid artery came in or some vessel was not carried away. Spots in the vitreous are sometimes the remains of these vessels. We see remains of hyaloid artery at times but persistent fibro-vascular sheath is very unusual.

If you see what appears to be a retinoblastoma remember a tunica vasculosa lentis can give this appearance. Of course, it is possible the eye with the fibro-vascular sheath would never develop properly. If a differentiation can be made it will save the child an enucleation.

Suggestions for differentiation-

If the retinoblastoma is large enough so you can see it just behind the lens you can be sure the eye is blind. But if you flash a light and the other pupil responds you know you have a consensual reaction. Consequently, if you get a pupillary reaction leave the eye in because it cannot have a retinoblastoma. However, if you are uncertain at all, enucleate.

Pupillary membrane- if you have a persistent pupillary membrane you can frequently see it with the slit lamp. You can see just a few strands coming across and perhaps see bits of pigment on the lens. When you see that, you can be sure it is congenital pigment.

Surface Ectoderm	Neuroectoderm	Mesoderm
Epithelium of lid conjunctiva and cornea	Retina- pigment layer neuro-epithelium	Uveal tissue
Lid glands	Ciliary body epithelium	Sclera
Lacrymal glands Nasolacrymal passage	Iris 1. epithelium 2. dilatator 3. sphincter Optic nerve Part of vitreous ? uveal pigment	Substantia propria of cornea Lamina cribrosa Iris angle Part of vitreous Tenon's capsule Extraocular muscle ? ciliary body muscle

	Anterior Zone		Middle	Posterior	
Tunica Fibrosa		Cornea Anterior chamber		Sclera and Prechoroidal space	Lamina cribrosa
Tunica Vasculosa	IRIS	Pars uvealis iridis Sphincter	Ciliary Body	Uveal Part Choroid	
Stratum Pigmenti		Dilatator and part of sphincter		Pigment epithelium Pigment epithelium retina	
Tunica Interna		Pigment epithelium iris	Pars iridis retinae	Unpigmented epithelium Retina proper	Retina and part of optic nerve

The embryo is transparent in the beginning. As it develops it becomes more opaque. The lens, vitreous, and cornea, however, are tranparent. The transparency is maintained by arrangement of the tissue and the fact that they contain muco-protein. In the adult, you do not find muco-protein anywhere else in the body.

Various conditions that may be produced by congenital anomalies:

Symblepharon, amblyoblepharon, epicanthus, ectropion, entropion, trachomas, epitarsus, ptoses, double canaliculi, corectopia, polycbers, anesochoria, dislocated lenses, lenticonia, melanosis, heterochromia, albinism, medulated nerve fibers.

Ronas - Trans. A.M.A. 1934 work on lenticonis
Lloyds - Trans. A.M. Ophth. Soc. 1934

Development and growth of the human Eye-

At birth the eye is not fully developed. In every new born human baby the eye is a "wandering eye". Possibly the macula is not fully developed as the optic nerve is not myelinized. It may take light and usage to develop the macula. If the macula is never developed, the ability to see keenly, we refer to the condition as amblyopia ex anopsia.

At birth the eye is 16-17 mm. in diameter. The equatorial diameter is greater than the long diameter. The cornea is comparatively larger in comparison to the rest of the eye being 9-10 mm. In the eye at birth there is very little iris pigment. The eyes are usualy blue and some turn darker later. The retina does not grow very much but the retina in the foetus or just about at birth comes into contact with the ciliary processes, then, as the eye grows the retina is pulled further back. The moiree silk appearance of the retina is due to tiny folds in it. The relative amount of growth is small in comparison with the rest of the eye. The ciliary

body is short at first and the anterior chamber is shallow. At three weeks of age, the optic nerve is medullated. At this time the child starts to use the two eyes together. The eye grows very rapidly during the first year and from the 14th to the 20th year. The lens has the potentiality of growth throughout life.

The cornea flattens as the eye lengthens and the lens grows. There is a balance between the flattening of the cornea, the growth of the lens and the enlargement of the eye, so that the eye remains more or less emmetropic.

The cornea is almost fully grown the first year.

The distance from the optic nerve to the fovea runs about the same throughout life. This indicates that the retina does not grow very much.

Maturation of the Eye-

Descemet's membrane gets thicker in places, particularly at the periphery giving rise to so-called "wart" formation.

The lens nucleus increases in size.

Cystoid spaces in the retina appear especially at the ora serrata. This may also have something to do with separated retina.

Clump cells in the iris. The iris pigment is broken down and phagocytized probably. The blood vessels of the iris are thickened. The vessel wall is much thicker than the lumen, and is hyalinized.

Corpora amylacea.

Colloidal excresences- Druse's formed.

Cornea

Anatomy, Histology and Physiology-

The cornea retains its transperency. The cornea is thinnest at its center. An exaggeration of this thinness is probably the cause of keratoconus. The anterior surface of the cornea is a geometric curve. The inner surface is more parabolic. The epithelium of the cornea is the most regular epithelium in the entire body. The epithelium rests on the basement membrane, Bowman's. There are some cells that rest on this which are regular, columnar, and also occasionally you see wandering cells between the columnar cells and Bowman's membrane. The epithelium has protoplasmic bridges connecting one cell with another in a fiber basket arrangment. Nerve fibers come up between the cells. Between the cell bridges there must be some lymphatic drainage in the cornea. Both the epithelium and the stroma probably make up Bowman's membrane. Bowman's membrane is not a true elastic membrane.

Work of Lewis-

Geometric Type of cells Harvard Medical School

He has studied the dimensions of the cell and says that cells tend to be fourteen sided.

Cornea Substantia Propria or Stroma-

The stroma makes up over 90% of the cornea. It is comprised of white fibers that are arranged parallel and in layers running at angles with each other. There is an occasional fiber which runs from one layer down into another. These cells in the substantia propria lie in little canals. These cells form a synctium, i.e. protoplasmic continuity between the cells. The little spaces around them permit the wandering cells to enter. Here, there is a lymphatic supply also that is supposed to nourish the cornea. Dr. Terry feels that this is true in part but thinks some of the nourishment comes from aqueous.

Descemet's membrane-

This is the internal limiting membrane which is a true elastic membrane. It apparently ends at the edge of the cornea but actually it is continuous over the filtration angle to the surface of the iris but it is very, very thin past the edge of the cornea. It is more resistant to infection than Bowman's membrane resulting sometimes in a Descemetocoele.

Mesenchymal epithelium-

This is a peculiar epithelium. It is low cuboid and covers the posterior surface of the cornea as simple squamous epithelium over the lamina cribrosa and the filtration angle onto the iris but it is not a continuous sheet over the iris being absent over crypts at least. This epithelium must be extremely important to the well being of the cornea. In instances where the so-called endothelium is diseased or absent edema of the cornea results.

Physiology of cornea-

The curve of the cornea is such that we get our best vision through the center of the cornea.

Nutrition

Nutrition is supposed to come from loops of blood vessels at the limbus. It is uncertain if the cornea receives nutrition from the aqueous. However, atropin and cocaine will go through the cornea. Actually every time we find pannus degenerativus we find we have a ciliary body that is destroyed and a diseased aqueous. This is an argument fro the fact that the cornea obtains nourishment from the aqueous.

Ex- vascularization of the cornea is common in instances of stagnant and unhealthy aqueous.

The cornea respires directly from the air taking in oxygen and throwing off carbon dioxide.

Duke Elder's work-

Takes eye out and leaves it in oxygen and the cornea stays transparent. If you take an eye out and exclude oxygen the cornea becomes opaque.

Faltivow-

Has done a great deal of work with the cornea. He can keep the cornea alive three days after enucleation, transplant it and get a successful graft.

Castroviejo-

Takes cornea from still born babies- uses several hours later. But if the oxygen is cut off the cornea dies. All this indicates that certainly the cornea breathes.

If one has any foreign body of the cornea or abrasion of the cornea the epithelium will regenerate. If Bowman's membrane is destroyed the epithelium fills up the gap. If the substantia propria is injured a scar is formed which persists. Therefore, with foreign body of the cornea locate the foreign body accurately and draw a diagram. If the case is a medicolegal case the diagram will be very useful. The epithelium always fills up the gap and keeps smooth the surface of the cornea unless the injury is so deep the curve cannot be maintained.

Ex- Herbert's pits

This occurs after trachoma and one has dimples on the cornea and the epithelium is destroyed in part.

Penetrating Wound of the Cornea-

A wound penetrating all the way through the cornea, no matter what cause, the method of repair is the same. The aqueous flows out and you have a plug of iris that frequently fills the wound. But if there is nothing in the wound and it tends to fall together nicely, the tissue swells. There is a coagulated albumin glueing the wound together. This breaks down as intraocular pressure rises and builds up again and again until the wound adhesion can withstand intraocular pressure and movement of the lids. Every time the wound breaks down it is like suction on choroidal vessels. This trauma to the retinal and choroidal vessels may give hemorrhages of the choroid and retina and may result in an expulsive hemorrhage. Consequently, use a flap and stitch the wound together every time you can with cataract extraction.

Wounds of Cornea (continued)

Swelling of the stroma brings the edges of the wound together in the posterior half of the cornea. Fibrin seals this and the anterior chamber is re-established until the rise in intraocular pressure is enough to break it open again. There is finally a growth of scar tissue uniting the substantia propria. This takes quite a while. The epithelium proliferates and fills the gaping anterior triangle. Descemet's membrane being elastic, retracts from the cut, and the edge of it curls up. The mesenchymal epithelium fills up the posterior triangle. It takes from a few hours to a day for the epithelium to fill up the triangles but longer for the posterior triangle to be filled with so-called endothelium. The newly formed epithelium is actually destroyed or pushed out as fibrous tissue is growing across the gap in the stroma. The layer of endothelium forms a new Descemet's membrane which connects with the old Descemet's membrane. Bowman's membrane does not re-form. The uniformly curved surface of the cornea is maintained.

Scar tissue formation- inflammatory cells and wandering cells take away the debris. As time passes, this tissue contracts and the wandering cells disappear. Through the microscope it may be difficult to tell the difference between scar and cornea -can do this by looking for the break in Bowman's membrane and by looking for the difference in Descemet's membrane. Figure 4.

Complicated Wound-

A complicated wound with infection or with foreign material in it heals much more slowly. Even after putting a flap over the cornea the wound with prolapsed iris, lens capsule and etc. in it, does not grow together as quickly or firmly. You must prepare the flap on which there is no tension, if you can. It is best to treat a complicated wound by cleaning it out. You cannot always see material in the wound. Whenever you have a prolapsed iris coming through the wound pull it off so that the retraction of the cut edges will pull the remains of the iris into the anterior chamber some distance from the wound.

If you find lens material- use an iris repositor to get the material out.

If you feel the chances of infection with iris in the wound are small and that the iris has been there for only a short period of time one can tuck the iris back into the eye without an iridectomy but one must be sure when the iris goes back that it will not re-prolapse or form a synechia. Also, that the anterior chamber will be reëstablished. If one is uncertain as to the result it is best to do an iridectomy. In only a few cases it is really safe to reposit the iris.

Grafting the Cornea-

Thomas in England, Castroviejo, and Faltivow are doing a great deal of work on this.

Thomas-

trephines a circular piece out and puts it in the other eye. The difficulty with this method is the tissue tends to go into the eye.

Faltivow-

uses an apparatus that is made out of celluloid with a hole on each side of it. This gives a back stop for the anterior chamber and prevents injury to the iris and the lens.

This grafting of the cornea is most successful with healthy eyes except for corneal opacity. Can do this with burns of the cornea. Must study with slit lamp to find out how deep the opacity is in the cornea.

Corneal tissue is really ideal for grafting. Grafting is more easily done with tissues that have poor circulation, the less blood vessels there are the easier grafting is. The dangers of corneal grafting are pressure in the eye, synechia, and cataract formation.

Thomas tries to keep button from going into the anterior chamber. If one puts a stitch on either side of the inserted tissue one will get vascularization.

Castroviejo- He made an instrument that looks something like a compass He can put different blades in this instrument. He thinks one should use a square. Puts the instrument on the eye, cut two strips one way and two strips the other way. Can cut rather deeply into the cornea. He prepares the other eye the same way. He stitches completely so the tissue will not drop out. He also makes a flap. He has gotten fairly good results with his grafting. The eye have had good vision.

The difficulty in making progress in this grafting is the matter of obtaining good normal cornea. Castroviejo does not believe blood grouping is important in this because there is no blood in the cornea. Why cannot you make animal cornea grow on human- asks Castroviejo. At the present time he is using the cornea of still-born babies and says he can get the cornea of a cat to grow on a dog and vice versa therefore, he concludes why can't you transplant the cornea of monkey to man because man and monkey are more closely related than the cat and the dog.

Optical iridectomy- must be done to give the person a pupil or the scar is in the center of the cornea.

If the grafting is unsuccessful fibrous vascularized tissue forms and you have cornea that is useless. One dangerous but rare complication in all perforating wounds whether traumatic or accidental, is growth of surface epithelium into the anterior chamber. It should be prevented if possible by trying to get prompt normal healing of wounds and keep them free from tags of conjunctiva which might be caught into the wound edge. In almost all perforating wounds the epithelium goes deeply into the wound often to- but not into the anterior chamber. There must be some additional factor probably injury or destruction of mesenchymal epithelium at the edges of the wound so that the surface epithelium can get a foothold there. Such a condition will certainly destroy the eye. This downgrowth of epithelium gives a milky appearance on the iris. However, Vail proposed an interesting treatment in the use of radiation. He found in the literature some nine patients treated with X ray or radium which stopped the growth of epithelium down on the iris.

see Arch. of Ophth. 1936

Ulcerative Keratitis

There are acute, chronic and subacute types.

Acute ulcerative keratitis may be associated with hypopyon in which case it is usually caused by the pneumococcus. Figure 5

Pus in the anterior chamber due to the force of gravity falls down to the bottom in the anterior chamber forming a hypopyon. A patient who changes position frequently will stir the aqueous and the hypopyon will disappear. If one fills [illegible] pus as with the slit lamp and there is no circulation of the aqueous the cells will drop down and form a hypopyon. The thermal circulation of the aqueous will not keep the hypopyon from forming. This pus does not come from the wound or ulcer. Unless the ulcer has perforated there are no bacteria within the eye. Can have a hypopyon with metastatic endophthalmitis or severe iritis. The pus comes from the iris and the ciliary body, chiefly the ciliary body. The toxins that get into the eye from the corneal ulcer produce a toxic iridocyclitis and it is this iridocyclitis that is responsible for the ulcer. As long as there is no perforation a hypopyon is sterile.

Pneumococci affecting the eye are smooth, i.e. they are encapsulated. Pneumococcus in the capsule cannot be attacked by anti-bodies but those not capsulated can be attacked by natural and acquired resistance. It has been found that the capsule is a polysaccharide.

At Rockefeller Institute- a great deal of work has been done on the pneumococcus. After much time and labor it was found that an enzyme from the cranberry bog would tear down the polysaccharide. However, nothing of clinical value has come from the work as yet. Bile dissolves the pneumococcus but it cannot be used in the eye as it also destroys corneal epithelium.

In the eye, most of the time the pneumococcus comes from the conjunctiva or conjunctival sac. It is rare to find that pneumococcus contaminates the object that scratches the eye with the exception of babies' fingernails. There is almost always a history of injury of the cornea. Most of the infections are already in the eye. We see hypopyon ulcer more frequently with eyes that have had a disease which decreases local vital resistance.

Sometimes, the pus cells will stick on the back of the cornea behind the ulcer. The cells hang down into the hypopyon. This is referred to as an "onyx".

Iritis in connection with Hypopyon-

Convection current of the aqueous. The iris is warmer than the cornea, because the aqueous near the iris heats it up rises, then cools in contact with the cornea to fall. This accounts for the convection current of the aqueous. This circulation is least pronounced in a triangular area with its base down and its apex toward the pupil. This may account in part for the "onyx". There is possibly not enough current to move the cells so they stick to the back of the cornea. However, there must be another factor because an onyx is not a constant finding in hypopyon ulcer. If the toxins produce a thick plasmoid aqueous at times this aqueous may coagulate.

Ulcers (continued)

One can have other organisms producing hypopyon since hypopyon formation depends on concentration and virulence of the toxins. However, it is wise to treat all hypopyon ulcers as if they were due to pneumococcus.

Severe iritis can cause a hypopyon.

One may see an eye perfectly white and quiet yet see what appears to be a hypopyon. When one finds this condition it is usually associated with retinoblastoma, the "hypopyon" being masses of tumor cells. Strangely, necrotic retinoblastoma does not produce an inflamed eye.

What an Ulcer of the Cornea Does-

It causes a loss of epithelium, an invasion of bacteria, necrosis, and exudate of leucocytes.

If a blind eye develops with a hypopyon ulcer remove the eye rather than treat the ulcer. Convalesence is shorter and cosmetic results better. There is some danger of sympathetic uveitis if the ulcer perforates.

There sometimes develops a "posterior abscess" of the cornea, pus cells in between the stroma and Descemet's membrane. The pus cells got in from the periphery in front of Descemet's membrane. This posterior abscess is probably the result of toxins going through the eye and concentrating at that point. Because of posterior abscess it is believed by some observers that some ulcers perforate from behind. The posterior abscess is more probably secondary to the toxins rather than produced by bacteria. It would be a long time before the posterior abscess could beabsorbed.

Progressive and Regressive Stages of Hypopyon Ulcer-

Progressive ulcer	Regressive ulcer
marked inflammation	less inflammation
sharp edges	rounded edges
infiltrated margins (out past ulcer)	clean edges
uneven dirty floor	floor cleaner, more even, and more transparent

Progressive-

This has pus cells undermining edges of ulcer, a definite hypopyon, onyx, base is relatively clean, cells do not live well in own katabolic processes. The undermining invasion of the bacteria calls forth pus cells and gives rise to necrosis which gives a yellowish ring at the edge of the ulcer. Ordinarily, if you see the yellow ring it is indicative that the ulcer is spreading.

Remedy this by cauterizing it. Then follow the eye daily. It is difficult to tell whether the ulcer is getting better or worse. You may cauterize and kill the bacteria but it may be reinfected from the conjunctival sac or the tear sac. Therefore, it is well to wash out the conjunctival and tear sac.

Slide- showing that Descemet's membrane is not strong enough to resist the intraocular pressure and it herniates out and produces a descemetocoele. When you think this going to occur the ulcer will perforate.

Operations-

Saemisch operation- take the cataract knife and put it in on one side of the cornea at the edge of the ulcer and pull it out at the other edge. Just bisect the ulcer. The aqueous seems to destroy the bacteria and it is an aid in healing after this operation.

Reopen the wound daily with iris repositor keeping the anterior chamber flat so that the aqueous will wash the wound, and so that the cornea will be relieved of pressure.

Delimiting Keratotomy- Can do the keratotomy at the edge of the ulcer. There are many variations of this operation. It is chiefly to keep a part of the cornea clean that you expect to give the patient vision.

Some prefer actual cautery- heat the cautory to a cherry red and cauterize in the region where the cauterizing will have full effect on the thickness of the cornea plus the cornea produced by this condition. One thorough careful application of this will cure most of your patients with hypopyon ulcer.

"Pasturization" can see the effect of drying. But there are other methods such as cauterization where you can do this.

Use of Thermaphore- This instrument heats up with electric resistance. It has varying sized tips which is sometimes disadvantageous because you may not be able to get just the size tip that you want to fit your ulcer. Must be careful not to pasturize normal cornea becuase you will devitalize this tissue and make it better ground for invasion. Usually pasturize for one minute. The temperature must be high enough to kill the bacteria but not the tissue.

Chemical cauteries- use these fairly frequently on ulcers of the cornea. It is good for chronic ulcer. Use full strength iodine. Dr. Terry does not trust the use of iodine with pneumococcus ulcer.

Staphyloma of cornea- Figure 6

Staphyloma of the cornea often is the end results of an extensive hypopyon ulcer. The cornea is necrosed and lost and the iris only remains as the anterior surface of the globe. The pupil is blocked by exudate and later organisms. With this the aqueous accumulates in the posterior chamber. The pressure goes up and secondary glaucoma causes the scar tissue in the anterior segment of the eye to bulge forward as staphyloma and there is not much you can do about it.

Staphyloma Solidum

Staphyloma solidum results when there is an excessive overgrowth of the scar tissue replacing the iris.

Leucoma Adherens-

If the corneal ulcer heals with leucoma of the cornea to which the iris adheres the condition is called leucoma adherens.

Ring Abscess of the Cornea

Ring abscess is caused by an endophthalmitis which may have its origin from ruptured hypopyon ulcer, perforating wound, from meningitis or from metastasis. The abscess is out near the periphery and is typically yellow. It extends around the corneal circumference but within corneal tissue a millimeter or more from the limbus. Pus cells enter the cornea from the periphery in response to toxins in the cornea but the invasion is stopped short probably by negative chemotaxis.

Catarrhal ulcer of cornea-

Frequently associated with acne rosacea. Use ointment # 116. Many find catarrhal ulcer associated also with gout and other debilitating conditions. Most of these ulcer respond well to rosacea treatment and lowering of the carbohydrate intake materially. More lately the dermatologists have come to believe that fat, particularly in connection with chocolate is the offender.

Ointment 116 R/ Bituminous
Zinc oxide
Petrolati

Ulcers with Gonorrhea

Although the gonococcus destroys the epithelium it is probably due to other organisms that the stroma is destroyed.

Rodent or Mooren's ulcer

This ulcer slowly creeps over the cornea and progresses until the whole cornea is destroyed by it in spite of anything you can do. Dr. Verhoeff feels that if the ulcer is cured than one is not dealing with Mooren's ulcer. Frequently, this is considered as tuberculosis. Dr. Gifford recommends use of delimiting keratotomy in this condition also.

Syphilitic Ulcer -

Intractable ulcers in people with syphilis have healed rapidly after use of antisyphilitic measures but whether this is true syphilitic ulcer is improbable.

Treatment-of ulcers

Silver nitrate may be used but is exceedingly painful.

Jervey- believes in administering insulin for building up vital resistance of patients which in turn is good for the cornea. Many do not think insulin can do much for the cornea.

Ulcers (continued)

Unperforated ulcer of the eye is accompanied with sterile hypopyon if the hypopyon is present. This is important therapeutically. There is no point in trying to take out the hypopyon. By leaving it in the hypopyon tends to prevent the iris from prolapsing as well as tends to prevent the lens from prolapsing.

Herpetic Conditions-

There are a number of diseases of the eye which we call herpetic lesions. Can have herpes of the cornea with ulcer resulting, or can even have a hypopyon. There are also a group of conditions that have not been well differentiated. We do not consider these as true herpes, according to Dr. Gundersen. These are disciform keratitis, and superficial punctate keratitis, some of the corneal 'dystrophies associated with this because the patients have poor sensitivity and absence of corneal sensitivity. However, we have no right to say they are due to herpes simplex or herpes Zoster.

Superficial punctate Keratitis

Superficial punctate keratitis is accompanied by anaesthesia of the cornea with true superficial infiltration of chiefly chronic inflammatory cells and sometimes the epithelium is absent.

Keratitis Profunda-

It is a deep infiltration into the cornea and is associated with corneal anaesthesia.

Disciform Keratitis

This is really a good descriptive term, an opacity of the cornea that has a disciform shape. The infiltration is not as deep as in keratitis profunda, and may even get ulcerative changes.

Bullous Keratitis Figure 7

Definition-ordinarily, that condition of the cornea where bullae or vesicles tend to break down and we associate this with diseases of the mesenchymal epithelium of the cornea and glaucoma.

Changes characteristic of bullous keratitis-

1. vesicles separating epithelium from Bowman's membrane.
2. edema of the cornealstroma- bear in mind other things can cause edema of the cornea.
3. increase in the number of wandering cells present.
4. increase in the number of fixed cells.
5. tends to give permanent scarring.
6. may find several layers of Descemet's membrane.

After a long period of time the epithelium is broken down, lost, and grows back again. There is a tendency to regeneration of Bowman&s membrane. Some think this is more of a hyalinization process.

Dr. Green discussed treatment for bullous keratitis (Epithelial Dystrophy) at the 1935 Amer. Ophth. Society Meeting. His work is founded on the observations of Thomas Allen's that removal of epithelium and Bowman's membrane stops the process. He does an operation in which he splits the anterior layer of the cornea. It will epithelialize over and he believes that the epithelium will be more adherent than if Bowman's membrane was present.

This makes one feel that the epithelium in keratitis is not bound to Bowman's membrane as tightly as it should be. All this is theoretical, however.

Dr. Verhoeff had a case of a woman 45 years of ago who had bullous keratitis with the menopause. It persisted without the appearance of any glaucoma for some time, but finally glaucoma really did develop and the eye was enucleated. It was then found that Descemet's membrane was torn off over a relatively large area and hung down into the anterior chamber as an apron like fold. It may be congenital or due to trauma of some nature. One can see four different layers of newly formed Descemet's membrane. Each time the endothelium had to be replaced through disease or desquamation incident to the abnormal state of affairs a new layer of Descemet's was laid down. This one case illustrates the importance of normal healthy endothelium.

Experimentally it has been shown that the cornea can withstand 200 mm. pressure of mercury without developing edema if the endothelium is intact.

With severe glaucoma a steaminess of the cornea is frequently present. When the pressure in the eye is reduced by operation the steaminess disappears instantly. This steaminess cannot be edema because edema would not dissipate so quickly. It must be due to a stretching and re-arrangement of the corneal stroma.

In every bullous keratitis case studied in this laboratory the mesenchymal epithelium is diseased or absent.

Fuch's Epithelial Dystrophy so-called

Fuch's epithelial dystrophy so-called is an endothelial disturbance. The altered endothelium allows aqueous to enter the stroma in sufficiently large amounts to produce small vesicles. In severe cases these vesicles can be seen grossly but more frequently they are seen only with the slit lamp and are associated with irritation of the eye. Often one sees small points of staining of cornea where vesicles have ruptured.

Conical Cornea

The cornea is too thin more or less in the center and is unable to withstand normal pressure of the eye. Usually there is a break in Descemet's membrane at or near the apex and ultimately the apex of the cone of the conical cornea is opaque. If it is not opaque the conical cornea is almost invariably of small amount. Several things that may cause this:

a. may be linked with progressive myopia where a stretching of the cornea occurs rather than of the back of the eye with posterior staphyloma formation.

b. Cornea may not have enough strength to withstand intraocular pressure.

c. May be an exaggerated thinning process of the cornea as the cornea normally comes relatively thinner in its central area as a part of natural developement.

Fascicular Keratitis or Wandering Phlyctenular

Phlyctenules occur on the conjunctiva or cornea. There is an accumulation of macrophages, necrosis of center and loss of tissue. This is associated with tuberculous allergy in those who have had some lesion of tuberculosis. Since the onset of the tuberculosis is early in life in these instances they may have been bovine tuberculosis. Because of this Dr. Verhoeff has aptly said that the cause and cure is milk.

Wandering phlyctenule, however, is something quite different. It is also called fasicular keratitis. The typical picture is that of chronic corneal ulcer associated with vascularization of the cornea. The "apex" of the vascularized area is the location of the ulcer. As the ulcer extends and the vascularization follows, the condition bears the term of "wandering" phlyctenule.

Hematogenous Pigmentation of the Cornea

This results from hemorrhage in the anterior chamber. Usually though not always the anterior chamber is completely filled with blood and usually, though not always the patient has glaucoma. These patients at least have a tendency to have high intraocular pressure. As the blood in the anterior chamber undergoes the process of resolution certain materials from this blood probably hematoidin, certainly not iron containing blood pigment, passes into the cornea through intact Descemet's membrane into the cornea where it is precipitated by some constituent of the cornea. This pigment gives the cornea a greenish color and looks like a dislocated lens in the anterior chamber. As it clears, blood vessels grow into the cornea. Thus, we consider the prognosis of this rather bad. To prevent this condition it is alwayswise to wash out the blood from the anterior chamber. Sometimes, after operation the anterior chamber is full of blood, or it may not be filled with blood until 2-3 days after the operation. In any case, in order to prevent this condition keep the anterior chamber washed out and free from blood .

Pannus of the Cornea

There are several things we speak of as pannus. Ordinarily, we associate it with trachoma. The virus probably involves the cornea and blood vessels grow anterior to Bowman's membrane. Pannus of the cornea is quite different from deep vascularization of the cornea. In the latter, the blood vessels branch slightly or not at all whereas in superficial pannus the blood vessels are more branching. Pannus may also be associated with a fasicular keratitis, and with phlyctenulosis.

Pannus Degenerativus

This condition comes on after glaucoma, uveitis, or some condition that has made the aqueous very abnormal. The pannus is in that part of the cornea farthest away from the aqueous. It is a growth of blood vessels and granulation tissue into the cornea. At times, this is progressive so that the granulation tissue runs ahead of the vessel formation. It is regressive if the vessel formation is ahead of the granulation tissue formation.

Band Keratitis

Band keratitis is a degenerative change of the anterior portion of the cornea that is exposed when the eyes are open. Leprosy of the cornea does occur. Tubercles, foam cells in the so-called lepra cells are present. Lepra cells are phagocytes filled with lepra bacillae.

The Lens

Embryology-

With optic vesicle formation there is a thickening of the ectoderm over the vesicle. This thickened ectoderm becomes depressed into a cup and later is cut off from the surface with the formation of the optic cup. In Figure 3 note the formation of lens vesicle. It is obvious that the inner surface of the lens vesicle represents body surface. Then the lens capsule represents basement membrane and nucleus formation of the lens is a keratinization process of surface ectoderm. In developement the anterior capsular epithelium remains a low cuboid epithelium through out life. The cells of the posterior capsule grow longer and fill the vesicle. This growth occurs at the equator. Old fibers are pushed centrally so that they finally lose their contact with the lens capsule as well as their nuclei and become keratinized thus forming the ever increasing lens nucleus. The lens has the potentiality of growth throughout life as do the hair and the finger nails. The individual fibers of the lens are not long enough to reach from the anterior pole to the posterior pole of the lens. The Y and would Y and the lens star represent lines along which lens fibers end against other lens fibers running in a different meridian. The lens is able to get larger by proliferation or swelling of fibers or a combination of both.

The lens must get nutrition from the vitreous and aqueous through the lens capsule and the aqueous and vitreous get their nutrition through a semi-permeable membrane of the ciliary body. Anything that changes the metabolism of the eye can affect the lens.

Work of Kirby Trans. Acad. of Ophth. 1932

Describes his work on the growth of lens material in culture. He tested the rapidity of growth where the amount of various constituents such as sugar, potassium and sodium was artificially increased or decreased. His work is interesting but not directly applicable to our treatment of cataracts.

Lens contents:

1. contains the proteins: alpha and beta crystalline
2. glutothion
3. lipoids- which with cataract formation break down into cholesterins and fatty acids.
4. salts and sugar- sodium chloride, calcium, zinc, phosphorus, potassium, etc.
5. vitamin A in large concentration.

Changes in Lens-

There is a lag between changes in the blood and the aqueous. Something must happen to the metabolism of the lens when the blood sugar goes way up or way down as it normally and even much more abnormally does in diabetes before treatment is instituted or in a patient who does not play the game of insulin and diet fairly. If the change is very rapid, the aqueous may not be affected, but if the change is gradual the lens will be affected. The sugar in the lens will be changed from way up to way down and vice versa.

Changes in the lens can cause the lens to imbibe more fluid and swell up. This might explain the condition of intumescent lens.

Practically the only real changes we get is the opacity formation-cataract. Strictly speaking, any opacity of the lens is a cataract. If a person has a very small opacity which does not interfere with vision it is not necessary to label the condition as cataract. The opacity may never develop further.

Classification of Opacity of the Lens-

(1) As to age of cataract

a. early change- incipient cataract. Some of the lens fibers become swollen are re-arranged, become opaque- may have spoke like opacities in this stage or later.

b. marked swelling of entire lens. "Intumescent cataract". There may be little if any opacity. The patient may grow rapidly near sighted and is frequently happy over the "second sight".

c. Incipient cataract- spoke like opacities, most frequently seen nasally.

d. Immature cataract- opacification does not extend to capsule.

e. Mature cataract- the whole lens is opaque.

f. Hypermature or Morgagnian cataract- all of the cortex- Figure 12 is liquefied and the nucleus by force of gravity falls down into the lower portion of the lens capsule.

(2) As to location

a. Anterior capsular cataract Figure 9

No posterior capsular cataract because there is no posterior epithelium.

b. Cortical cataract Figure 11
Can be anterior, posterior, or at the equator
c. Perinuclear cataract Figure 10
d. Nuclear cataract
(e. Exfoliation of the lens capsule- This gives an opacity but do not consider exfoliation as a cataract but is frequently associated with cortical cataract in the posterior of the eye.)

Capsular cataract

In capsular cataract the anterior capsular epithelium proliferates and forms into material that resembles connective tissue.

Causes: a. irritative phenomena
b. traumatic injury
ex- foreign body with small hole of entrance in the lens that is closed by proliferation of anterior capsular epithelium. There is usually some opacification of the lens cortex but as soon as the aqueous is excluded by blockage of hole in capsule so that aqueous is no longer in contact with lens fibers some of the cortical opacity may clear up. When there is a disease in the anterior segment of the eye- as ulcer of cornea that perforates the lens may come in contact with the wound edges and with repair of the cornea irritation to the lens may produce a so-called pyramidal cataract.

Cortical Cataract

Cortical cataract in changes more less in the following order
a. swelling of the fibers
b. waviness of the fibers
c. segmentation of the fibers
d. globule formation

In mature cortical cataract the fibers are broken down all the way around the lens. Congenital cataract may affect the entire lens- it is often hereditary.

Perinuclear Cataract (Congenital)

This is a cortical cataract that occurs very close to the nucleus. It is due to the fact that something interfered with the growth of the lens when that portion of the lens was growing. It may have been intra-uterine or just after birth. It most probably resulted from tetany and disturbed calcium metabolism. Often with this condition one sees an associated irregular formation of teeth.

However, tetany cataracts may occur at any age and are usually associated with removal of parathyroid glands when thyroidectomy was done.

Coralliform Cataract

Coralliform cataract looks as if there were pieces of coral in the lens. These pieces are the same color as coral and have the same appearance. They are some form of crystal and are a form of congenital cataract. The crystals can be studied microchemically . Dr. Verhoeff regards it as a protein crystal.

Nuclear Cataract (Congenital)

This is formed during intra-uterine life at the time when the fibers making up the nucleus were growing.

Cortical cataract usualy is a senile cataract. It tends to be familial. It may occur at the age of 45, or not until 70 or 80 or even 90 years of age. It is usually called senile cataract and is probably due to lack of nutrition or injury to the lens.

Complicated Cataract

This is a cataract that follows other diseases of the eye as glaucoma, uveitis, etc. It gives rise to cortical opacity of the posterior cortex, that portion of the lens farthest away from aqueous. This is the kind that is most characteristic of general metabolic disturbances of the eye.

Traumatic Cataract

The lens fibers swell, break down and liquefy if in direct contact with aqueous. One commonly sees the statement that the lens fibers are soluble in aqueous. This statement convey s a general idea but is probably erroneous [illegible] Any break in the lens capsule will give rise to an opacity. Can we get an opacity of the lens without a break in the lens capsule? Some say we must get a break in the capsule.

Contusion cataract- some people have contusion of the eye -refer to lens injury as contusion cataract. This opacity at first is of most any rounded or globular form but after a time the opacity grows smaller leaving the typical rosette or daisy like permanent form.

True Scondary Cataract

True secondary cataract is the opaque remanent after the old "extracapsular" or capsulotomy cataract extraction. The remaining cortex is covered by the remains of the capsule and protects the remaining cortex from aqueous. It may follow cataract extraction or trauma. This remains may swell, new fibers grow from the capsular epithelium-. This is spoken of as Soemerring's crystalline swelling. Figure 13.

Metabolism and Cataract-

There are certain cataracts that come on after use of napthalene. Also, after the use of di-nitrophenol some 100,000 people have used this drug to reduce. There have been 100 cases of cataract formation due to this drug reported. The opacity comes on with great rapidity. Nobody knows how this causes cataract formation as no animal experiments have resulted in this form of cataract.

In removing hypermature cataract one should remove it in its capsule or one will run a great chance of losing the nucleus in the eye. When the nucleus remains in the eye it acts as a foreign body. The hypermature material is toxic to the eye. It may go through the capsule and cause some uveitis. One should take the lens out before it reaches the stage of hypermaturity. This should be done even though the patient may have vision of 20/20 in the other eye with no evidence of cataract. Hypermature cataract may destroy the eye due to uveitis and certainly hypermaturity adds to hazards of cataract extraction.

It has been shown experimentally that the lens capsule has a lamellar structure after being acted upon by alkalies or acids. Occasionally, it is found that the lens capsule may split off a lamella or more. This tends to roll up slightly. It may break off and lodge on the iris sphincter and appear as "dandruff" on the iris. It may be carried to the filtration angle blocking it and producing glaucoma. At any rate glaucoma does arise frequently where there is an exfoliation of the lens capsule. This complication is so frequent that some ophthalmologists feel that an intracapsular cataract should be done routinely even if the lens is clear in this condition so that glaucoma will be prevented. Associated with exfoliation of the lens capsule often is cataract formation. Frequently, the cataract involves the posterior cortex and resembles the cataract typical of glass blowers. However, heat from occupation apparently plays no part in exfoliation of the lens capsule.

Dislocation of the lens- This condition is called subluxation.

When the lens is dislocated it is like a foreign body in the eye. It will dislocate rarely into the anterior chamber and is always followed by a glaucoma. It is more frequently dislocated backward into the eye after injury. This may seem difficult to extract but after making an incision the lens comes up into position. If it does not, it may be drawn up with an iris hook.

Slide- showing lens dislocated into episcleral tissue by contusion of the globe. . In certain instances when the lens capsule is broken and lens material is in direct contact with aqueous whether or not a so-called extracapsular lens extraction has been done the eye becomes inflamed.

Verhoeff and Lemoine regarded this condition as an anaphylactic reaction due to sensitivity of the eye to lens material. Much experimental work bore this out. They suggested the use of the term Phacoanaphylaxis and called the disease Phacoanaphylactic endophthalmitis. Patients who had this condition were found to show skin reactions of sensitivity to dessicated lens substance. For some years lens protein tests were done routinely at the Massachusetts Eye and Ear Infirmary until the intracapsular cataract extraction became popular. In event the patient was sensitive to the skin test he was carefully de-sensitized before the cataract extraction was done. Other observers tried to repeat this work with no success until recently at which time one observer found that the "phacoanaphylaxis" could be produced in the laboratory animal if a sterile bacterial filtrate were also introduced.

Whether or not this condition is an anaphylaxis of the body to normal tissue living in the body or whether or not this is a very low grade infection there is certainly a disease entity characterized by

1. Invasion of lens with polymorphonuclear leukocytes
2. Uveitis
3. Nodules of inflammatory cells on the retina
4. Papilloedema in some instances
5. Perivascular infiltration of retinal veins with inflammatory cells (called serous retinitis by Samuels)
6. Recovery from the disease after removal from the eye of the remaining lens material.

Therefore, in event of intractible uveitis after lens injury or extracapsular cataract extraction re-open the eye and wash out or remove all remaining lens material.

Diseases of the Uveal Tract

Since the iris, ciliary body and choroid can be dissected free from the remainder of the eye in one piece which resembles vaguely a grape the term, uvea, meaning grape, is applied to this structure. The uvea is attached very loosely to the sclera except by scleral spur in the region of Schlemm's canal and at the nerve head. The uvea is inseparably attached to the retinal portion of the iris and ciliary body whereas a potential space exists just internal to the pigment epithelium of the retina and the neuroepithelium of the retina. Because the retinal portion of the iris and the ciliary body are considerddto be a part of the uvea it is also as logical to consider the pigment epithelium of the retina as a part of the uvea also.

Remember that is is the ciliary body that extends from the ora serrata on to the scleral spur, and that the iris is attached to the ciliary body. The iris in the region of the sphincter rests on the lens.

It is important to bear in mind the blood supply of the uveal tract.

The vortex veins drain most of the blood from the choroid and some from the ciliary body. If these veins are blocked it raises the capillary pressure of the choroid and ciliary body.

Arteries- short posterior ciliary arteries into the choroid, and long posterior ciliary arteries to the ciliary body. Anterior ciliary vessels through the extraocular muscles. Also, have deep conjunctival vessels forming anastamoses with vessels supplying the ciliary body.

Retina- central retinal artery and central retinal vein, may be connected with choroid by means of the cilio-retinal arteries and optico-ciliary veins, but this latter is more rare than the cilio-retinal artery.

Choroid- The choroid contains five layers of vessels. Has large arteries becoming smaller to form the chorio-capillaris. The choriocapillaries are wider capillaries than one usually sees. In the macular region the capillaries are even larger. In the ciliary processes the capillaries are so wide that as many as 20 red blood cells can go along abreast. The venous return from those goes into the tortuous venules and then to a more external layer of veins. By means of the ophthalmoscope in an albino eye there appear to be many anastamoses of relatively large vessels in the choroid. However, serial sections of this show that the vessels are not anastamotic the appearance being the result of tortuosity of these vessels.

Between the vessels the supporting tissue contains pigment-cells we speak of as "chromatophores". They differ from the pigment epithelial cells of the retina. The chromatophores are pigment manufacturing cells and may be the cells from which the so-called choroidal "sarcoma" may arise. Certainly, the pigment epithelium of the retina is ectodermal in origin.

Work of Block and Masson tends to show that all pigment cells are ectodermal, therefore, the chromatophores probably are ectodermal also. Intervening between the pigment layer of the retina and choriocapillaris in the region of the choroid is a glass like membrane called lamina basalis or Bruch's membrane. There is a counterpart of this membrane between ciliary capillaries and pars ciliaris retinae. Internal to the choroid proper is the (1) pigment layer of the retina (2) and the neuroepithelium of the retina. Internal to the ciliary body is (1) a pigmented layer of the retina and (2) a single unpigmented retinal layer. We may think of this latter as the counterpart to the neuroepithelium. Near the region of the attachment of the iris to the ciliary body there is pigment in both retinal layers of the ciliary body. On the back of the iris the layer analagous to the pigment epithelium of the retina is now a muscle, the dilatator pupillae and the "neuroepithelium" is the tufted appearing layer of pigmented cells. This layer of the iris differs from the ciliary body in appearance as well as chemically since the iris layer has a strong affinity for glycogen and in diabetes takes on a cystic appearance due to the accumulation of glycogen.

The ciliary body can be divided into pars plana posteriorly and the corona ciliaris (ciliary process area) anteriorly. The processes are very interesting because the capillaries there are so wide and because ciliary processes increase the surface area tremendously lending credence to the belief that a chemical exchange and more probably a real filtration occurs here.

Figure 14 The ciliary muscle runs in three directions, radial, meridional and circular. It is smooth muscle.

The iris- The iris comes off the center of the base of the triangle formed by the ciliary body. The ligamentum pectinatum is uveal tissue. The iris is thinnest at its root. The more highly pigmented iris has pigmented cells in the stroma, which is a meshwork of connective tissue. On the iris surface the cells are compressed. This is called the anterior boundary layer. Presumably, it is covered with a continuation of mesenchymal epithelium of the cornea which is very very thin. It is present only in parts, lacking in the crypts. The crypts lack any

sort of covering and the aqueous is in direct contact with the iris stroma. In fact the spaces between the iris meshwork is aqueous. The pigment of the iris depends basically on the pigment in the posterior layer. If there is no pigment in this layer the eye has the pink color of the albino. The blue of the new-born babies eye usually is due to the absence of pigment and may get darker later on. However, if a brown eye is turning to blue it means there is a loss of pigment or iris atrophy. In eyes that are blue, green-hazel, etc. one will find brown spots. This is usually found if there is pigment in the anterior boundary layer. With a highly pigmented eye one has a great deal of pigment in the anterior boundary layer as well as in the iris stroma. In one instance the dilatator pupillae is accidentally stained. Figure 15.

Case of a patient who got a piece of soft iron in the eye some 10-15 years before the eye was removed. The iron disintegrated in the eye. The dilatator pupillae phagocytized the iron pigment. To ascertain this the melanotic pigment of the eye was removed by bleaching leaving only the iron pigment in the eye. The dilatator pupillae shows over the entire extent.

The uveal tract is an unsual structre. It has certain diseases we do not find in other parts of the body. Some think we do have other uveal tissue in the body such as the organ of Corti. Walker correlates the eye and the ear. There are a few diseases that seem to show an association of the eye and the ear such as

1. retinitis pigmentosa- we certainly get a deafness with this condition. It is a nerve deafness.
2. sympathetic uveitis- supposed to have bad hearing when sympathetic uveitis is at its worst.
3. Paget's disease -frequently get disturbances of hearing.

From this we may be correct in presuming that there is uveal like tissue in the organ of Corti.

Atrophy of Uveal Tissue - Atrophy of Iris

This occurs after synechia, after cataract extraction if the iris pillars are caught in the wound. It may produce a gothic-arch-like appearance. This stretching will make iris atrophy.

If a synechia is formed or the iris is out into the corneal or scleral tissue the iris is replaced by fibrous tissue. The epithelial layer remains, but the stroma may disappear almost entirely. With fibrosis of the iris, sometimes the iris will contract and the epithelial layer bends over giving an ectropion uveae. Remember that fibrosis of the iris changes the character of this organ. Normal iris when cut does not heal over. The cut blood vessels seal over and that is all. Figure 16

If the iris has fibrosed, however, it acts like any scar tissue. It will heal over, will tend to close any holes that are cut in it.

The iris at times undergoes some change which results in the growth of fibrous tissue and blood vessels on its anterior surface. The cause for this in a general way must be due to a need of additional blood supply by the iris. This newly formed vascularized membrane grows invariable in thickness from the merest trace to a membrane one half the thickness of the iris. This membrane is seen in instances of-

1. Hemorrhagic glaucoma
2. Malignant choroidal tumor- usually with glaucoma
3. Longstanding separation of the retina-usually with glaucoma
4. Retinoblastoma (only one case)

This condition differs from organization of exudate on iris surface. Samuels feels it is due to toxins in the eye. Friedenwald thinks it may be due to necrosis of iris.

With essential iris atrophy an extra pupil may form. The iris just disappears. Can transilluminate through areas incompletely atrophic with the slit lamp or just a flashlight. When essential atrophy is present a person usually, eventually gets glaucoma.

Waite- Amer. Jour. Ophth., Vol. 11., No.3. p.187, 1928

Atrophy of Ciliary Body

The ciliary muscle often atrophies, especially in glaucoma. The processes often hyalinize.

Sympathetic Uveitis

Some people believe this is an allergic reaction. That people are sensitive to their own uveal tissue. We know very little about the chemistry of allergy.

Rosenow- Worked with rabbits giving them serum or antitoxin for some time. Thought that the rabbit could not be used again. Somebody tested to see why the rabbits died. Found they had a disease called anaphylaxis. Found hemorrhage in the joints, skin, etc. The severity of the disease does not depend a great deal on

the amount of antitoxin.

Serum sickness- this comes in about one week after the antitoxin is given. The severity of this disease depends entirely upon the amount given. Patients can die with serum sickness.

Work of Dr. Lord on Serum Disease and Serum Accidents
Amer. Jour. Ophth., Vol. 11, page 451, 1928

Allergic reactions may account for many types of diseases.

The cornea, aqueous, vitreous, lens, and part of the retina have no supply of blood directly. Since proteins are held in the blood by a semipermeable membrane and since antibodies are carried by the blood then avascular tissues lack the protection of the antibodies in the blood stream. Possibly this explains many eye diseases. A person may get a bacterial disease that gives rise to toxins. These toxins are distributed around the body and get into the eye. The tissues of the eye may get sensitized to this particular toxin but an acquired immunity may be present in the blood. Later the patient may have another infection with the same organism. Toxins carried to the eye may produce an allergic reaction there. In the eye we may have an allergic reaction. We know in certain cases this is true. If a person has a positive tuberculin reaction and they are injected with tuberculosis one gets three kinds of reaction-

1. local reaction
2. general reaction manifested by fever
3. focal reaction-of the part in which tuberculosis is active and flares up. This is particularly true in the eye.

Calumet reaction- if you drop tuberculin into the eye of a person senstive to tuberculosis get a "positive" reaction in the eye. It may produce phylectinules. May even have the flare up with iritis or uveitis.

Work of Brown- Trans. A.M.A. 1934 also Arch. Opht.Vol12, p. 730, 1934 He has sensitized the eye with toxins from an organism. After an interval of 6,8, or 10 days he injects the toxin into an animal's system. Will get a flare up of an acute iritis in that eye. Brown further reccommends that cultures be taken in patients with iritis. Make skin tests with those organisms from foci of infections, then using a vaccine of organism giving a strong positive skin test. This fits in with the explanation of tuberculosis of the eye. A person may have a bovine or scrofulous reaction. Later, one gets tuberculosis of the eye. The eye will show a disturbing prolonged uveitis and one finds the patients have a positive tuberculous reaction.

Clarence King- says a person can still have tuberculosis and be de-sensitized to tuberculoprotein.

Some people think that tuberculin is of no value in the treatment of tuberculosis but if you have an allergic tuberculosis in the eye it may help that person.

Syphilis

We do not have any other disease comparable to interstitial keratitis. This is almost diagnostic of congenital syphilis although only one person has found one spirochete in the cornea in such cases, organisms get into the cornea and die. It is possible that infants get intra-uterine infecting syphilis, the organ starts to flare up one treats them, and then later it flares up. Later when there is an increase of treponema toxins in the individual an attack of interstitial keratis occurs.

Focal Infection

Definition- a localized area of bacterial growth from which the bacteria reach the blood stream, go to another organ and infect that part, that is, it starts a disease in the other part.

There is such a thing as focal infection.

Billings 1912 popularized the idea of focal infection. Surgeons started doing more operations. If a person had trouble with a joint, all the teeth were extracted-even though they were healthy.

Example of true focal infection- a person with an acute appendicitis the infection will get into the blood stream and cause pyemic abscess in the liver.

When a patient has iritis or uveitis, acute or chronic, and one cannot find any cause but does find pus in the teeth, gall bladder, or appendix rather think it might produce the condition. However, we do not really think that organs metastasize. One does not find any organism in the eye, except in metastatic endophthalmitis. Allergy explains better than focal infection the diseases of the uveal tract.

If one has a patient with iritis study them carefully to see if any portion of the body is pathological and if so, put that part in good condition if possible.

These patients with acute iritis will run a course about six weeks then the inflammation will subside. It may leave a synechia or secondary glaucoma but the iritis does subside. This takes just about the same amount of time it would take to go over the patient to find foci of infections, and have them removed surgically, and be on the way to convalesence. It would appear that the operation has cured the iritis. But the iritis may recur showing that the cause has not been removed.

Let the laryngologist decide if tonsils should be removed. If they are diseased and whether the patient has iritis or not they should come out.

In this country, we have figures showing uveitis, acute iritis, or iridocyclitis is caused in a large percentage of the cases by focus of infection.

In Europe- they believe syphilis, tuberculosis and gonorrhea account for the acute iridocyclitis in most of their cases. They say all their clinic patients have many foci of pus. They are not treated by dentists and do not have tonsillectomys done.

O.R. Lurie- Arch. Ophth., Vol.9, page 918, 1933 gives strong arguments against focal infection theory. In fact, he feels there is no such thing as focus of infection.

Rosenow- (Mayo) finds a selective activity of organisms. He takes the bacteria, for example, from some joint disease and injects these into a laboratory animal into the blood stream. Then, he opens up the joints of the animal and finds them teaming with bacteria.

It is objected that one will find the organisms not only in the joints but everywhere in the body. It is hard to make an exact analogy. If one could inject say ten bacteria or a certain amount one might get some results but bacteria cannot be injected.

Mills- California- 1924 gave a paper in which he found the cause of iritis due to amoeba in the stool, amoeba of a non-pathogenic type. On the basis of this he gave the patients emetine and the patients got better.

Verhoeff thought the emetine itself might have a specific benefit in uveitis. He has given patients emetine without even testing their stool and he thought it of some value.

Acute Uveitis

With this disease there is hyperemia, exudate, swelling, hyperemia and dilatation of vessels nearby, in the episclera and conjunctiva. May get some hemorrhage into the anterior chamber. Exudate gets into the aqueous and one may see a large number of cells floating around in the convection current of the aqueous. There may be a large amount of albumin in the anterior chamber and the aqueous may coagulate. Patients usually do not have a glaucoma with this. When there is an exudate, cells may drop down and form a hypopyon or the pus cells may adhere to the back of the cornea forming a Descemetitis, posterior precipitates. The precipitates usually do not tend to run together, are more or less uniform in size. The precipitates coalesce more and cover a large area of the cornea rather than be limited to a triangular in tuberculosis. With this there is a tendency to have a plastic exudate which may be nothing but thicker aqueous.

The iris tends to stick to the lens because of plastic exudate. If adhesions form and organize ultimately the synechia cannot be broken down, therefore, must dilate the pupil early use atropine to prevent this, or if the patient is sensitive use scopolamine. Or one may use adrenalin and cocaine injecting under the

conjunctiva. Some people put atropin crystals in the eye. Also,some have injected a small amount of atropin near the limbus. At the Infirmry we use adrenalin bitartrate jelly 1% or adrenalin borate 2% solution, put it in the conjunctival sac and leave it there for some time. This will sometimes break thesynechia. Atropin also puts the iris at rest and makes it less stretched out so that there is a better circulation and less pain because it puts the ciliary body at rest and usually helps control the photophobia to a certain extent.

Adler- finds with ths use of atropin that the aqueous tends to become more albuminous, i.e. a little thicker, and that with pilocarpin the aqueous tends to become thinner. He thinks this tends to control the pressure of the eye a little.

As a general rule if glaucoma and uveitis are associated together dilate the pupil. The tension may come down under atropin but if it remains high then paracentesis or adrenalin may be needed. If measures are not taken to dilate the pupil thenposterior synechia almost invariably results.

If uveitis condition is non-specific in type, some salicylates in massive doses are given. Some give as much sodium salicylate as 100 grains a day.

The eye usually recovers from the first attack but succeeding attacks tend to leave the eye in a worse condition.

Chronic Uveitis-anterior

This gives a very different picture. Perhaps, all one sees may be posterior precipitates. This condition is very apt to give synechia which seal the anterior chamber from the posterior chamber. The pupil may be blocked.

Chroiditis

In the acute one may observe an area in the fundus that has lost its marking and there are opacities in the vitreous. After the destructive phase is past you can see scarring, atrophy of pigment in the center and proliferation of the pigment epithelium of the retina. Anything that disturbs the equilibrium of the eye in that region seems to stimulate the pigment epithelium of the retina.

Sometimes, see a large number of people that have ropey vitreous opacities as the only evidence of previous uveitis.

Tuberculosis

Tuberculosis of the eye and its adenexa occurs in two forms, the acute destructive lesion of active tuberculosis and the so-called chronic ocular tuberculosis in which tubercle bacilli are rarely or never found.

The acute destructive lesions are tuberculosis as seen in most any part of the body. These lesions may be associated with active tuberculosis elsewhere, tuberculous meningitis, or even generalized miliary tuberculosis. Active tuberculous lesions may be found on the lids but the lesions of the eye itself are rare and cause rapid destruction of the eye. Those lesionsusually occur in the very last stages of tuberculous dissemination and are relatively unimportant to us because they destroy the eye and usually destory life soon after the eye involvement.

However, that large group of cases referred to as chronic ocular tuberculosis do not destroy the eye rapidly. They may never destroy the eye. Such lesions may be an episcleritis, iritis, choroiditis, papillitis. The lesions may be small and heal with little destruction. They may be massive lesions involving retina, choroid, and optic nerve. The following list indicates something of the types and locations.

1. Episcleritis (may involve sclera and uveal tissue beneath so treat as if interior of globe involved and look carefully for vitreous opacities).

2. Low grade iritis that produces posterior synechia, often obstructs pupil and often causes iris bombe.

3. Nodules on iris and Koeppe nodules.

4. Small nodules of ciliary body which give rise to posterior precipitates on cornea and vitreous opacities.

5. Chorioretinitis- lesions of various sizes which ultimately heal with heavy dense scar. These lesions when active often produce vitreous hemorrhages.

6. Lesions involving optic nerve- or near optic nerve- Jensens juxtopapillaris. destroys nerve fiber layer resulting in sector field defect. The microscopic picture of chronic ocular tuberculosis is giant cells, tubercle formation, nodular arrangement, necrosis, healing with scar formation. However, Koeppe nodules may be nothing more than a mass of plasma cells. The patients are extremely sensitive to tuberculo-protein as shown by the Von Pirquet test.

Verhoeff's experiment-

He found if you inject living tuberculosis bacilli in the eye, the eye will go to "pot" in a few days. That is acute tuberculosis. If you inject dead tubercle bacilli in the vitreous of the eye you will find chronic ocular tuberculous lesions. One can find scleritis, episcleritis and regions of tuberculosis in the eye. One gets lesions similar to those found in chronic tuberculosis of the eye.

This shows that tubercle bacilli reaching the vitreous can be disseminated through vitreous and aqueous to produce retinitis, choroiditis, to Schlemm's canal and lodge there to produce episcleritis and even keratitis.

A phlyctenule does not show giant cell formation. It looks like allergic reaction- inflammatory cells.

Tuberculous keratitis is rare. It involves the cornea deeply and irregularly and does not look identical with syphilitic interstitial keratitis.

Diagnosis and treatment is left for Dr. King.

Syphilis of the eye may manifest itself as in a variety of lesions:

1. Interstitial keratitis

A lesion of congenital syphilis occurring from infancy to adult life and affected little in severity or recurrences by antisyphilitic treatment, and heals with scar formation and vascularization of the cornea.

This condition is more than just an involvement of the cornea because the uveal tract may also be diseased. For that reason a mydriatic is an important part of the treatment.

It is reported that treponema pallida have been found in only one instance of interstitial keratitis and then only one organism. It has been reported also that in the stillborn infant with syphilis treponema are found in the cornea in large numbers.

Because of the relative dubious results from antisyphilitic treatment, the lack of treponema in the cornea during an exacerbation and because the syphilitic stillborn has treponema in the cornea this condition is thought by some observers to be an allergic reaction also.

2. Syphilis may give rise to gummata of the iris.
3. Lesions of ciliary body.
4. Of the choroid and retina.

The fundus may take on "salt and pepper appearance", pigmentary changes similar to retinitis pigmentosa and healed lesions of chorioretinitis, white in the center with pigment piled up at the edges.

5. Of the optic nerve head.
6. Primary atrophy of the optic nerve and
7. Possibly a scleral disturbance called brawny scleritis.

Colloidal Excresences (Figure 17)

Gutta, Drusens sometimes is erroneously called retinitis punctata albescens. This latter, however, is a peculiar form of disease related to retinitis pigmentosa.

Colloidal excresences and Drusens are more suitable. Pigment epithelium of the retina proliferates and "secretes" a basement membrane which produces a nodule or wart on Bruch's membrane- is formed usually by (1) pigment epithelial layer of the retina and (2) by the choroid. One of these stains acidophilically and the other basophilically so the two layers making up this can be designated. Over the Drusen there is fianlly a lost pigment on the top. There is no visual disturbance caused by this condition unless it involves the macula. If it involves the macula the vision is reduced. We know how it is caused but we do not know why.

Something must interfere with the pigment epithelium of the retina, it may be irritated or die in part and re-grow with a new basement membrane formation.

Rupture or Tear of the Choroid

The tear tends to be crescentic. Usually is associated with injury or contusion to the globe. The retina is in contact with the sclera. Hemorrhages hide the tear but are later absorbed. This must differentiate from coloboma of the choroid and healed chorioretinitis.

Separation of the Choroid

O'Brien -discusses separation of the choroid in Arch. Ophth. Vol.14, page 539, 1935.

Separation of the choroid occurs frequently after operations, rarely spontaneously. Separation of the choroid from the sclera may be caused by serum or transudate getting in there. Keep the pressure of the eye low and a transudation behind the choroid is favored. The fluid finds it easier to make it way into the superchoroidean than under retina.

There is most always a leak of aqueous from the eye.

With separation of the choroid one sees a grayish or dark area. If it is more advanced one may see two areas ballooning out. Later, it is jet black. One always finds it a lobular type because the separation is not powerful enough to tear the vortex veins. Will tend to make up four or five lobulated masses. When this condition is present there are two things to be taken into consideration, (1) separation of the choroid and (2) rupture of the choroid

Separation of the choroid transilluminates a little better than the ordinary eye but if there is blood or sarcoma producing the separation it will not transilluminate. The sclera is bound to the choroid with some very loose fibers, sort of a spongy like tissue and is not held on very firmly. In spontaneous separation of the choroid the anterior chamber is very deep whereas with separation from leakage of aqueous the chamber is always flat. The leak of aqueous can be demonstrated with the use of fluorescin. One will see the fluorescin being diluted at a certain place. With that, one knows exactly where the wound is leaking. One can cauterize this place and do a posterior sclerotomy. However, this latter operation is rarely necessary.

What happens when the choroid has been separated?

If one does nothing to these cases six weeks later or less the choroid is back into place. When the choroid is going back into place it takes a serrated or folded shape and the retina follows this. The pigment epithelium of the retina is turned into folds. That is enough irritation to cause heavy proliferation of the pigment epithelium. As this grows still further one sees the pigment piled up. When the choroid is completely back one has pigmented streaks. This is one type of pigmented streak. It does not run very near the disc. These streaks run parallel or perpendicular to each other. Instead of being heavy definite lines of pigment they tend to be like rosary beads. A certain definite time factor is present in this. If the choroid was separated from 1-6 weeks one would tend to see these pigmented streaks present.

Arterior-sclerotic pigmented streaks-

In association with choroidal arteriosclerosis there is proliferation of the pigment epithelium of the retina piled up over markedly sclerosed vessels. In various places the blood vessel walls are very, very thick These pigmented streaks are over the thick blood vessel walls. It was thought that these had something to do with retinitis pigmentosabut Vos and Siegrist has proven this is not the case.

Siegrist and Verhoeff consider these streaks to result from abnormal pulsation of veins and they think that pulsation is enough to cause proliferation of the pigment. If this is the case then why do we not have pigmented streaks over vessels that are completely closed for at one time they were partially closed? Certainly, it cannot be an increased pulsation by itself that causes this.

Angioid Streaks- Figure 18

Angioid streaks appear in the ocular fundus as branching jagged lines of variable width and more or less radiating from near the disc. They vary in color from dark brown to red- are below retinal vessels, usually are associated with a "halo" or decrease of pigment around the disc, with retinal and chorcidal hemorrhages and ultimately with destructive lesion of macula probably resultant from hemorrhage. However, circinate retinitis has been associated in more than one instance.

The streaks are associated with a peculiar skin condition called pseudoxanthoma elasticum in some instances, with osteitis deformans in other instances and like these two diseases tends to be familial. At times the streaks are present without association with the skin or bone disease. Dr. Terry was able to find angioid streaks by examining the eyes of patients with Paget's disease.

The patient usually has no symptoms unless a streak involves the macular region. In this case macropsia or micropsia may be present because of compression or stretching of rods and cones.

The only pathological lesion obtained shows the disease to be a fibrosis and contraction of the outer three fifths of the choroid with a resultant folding of the choriocapillaris and the pigment epithelium. Variation in amount of pigment in the epithelium causes variation of color- much pigment, brown streak, whereas little pigment will allow the piled up choriocapillaris to be seen giving a red color to the streak.

Remember that osteitis deformans is more common than apparent since clinical Paget's is only late Paget's. Most of the cases found now are not very advanced. The discovery of the disease is due to X ray study for some other condition. Paget's most commonly involves vertebra and sacrum, rather commonly the skull the tibia in only 8%, and it may involve only one bone of the body. Therefore, the disease is excluded only by negative findings of the entire skeletal system.

Sympathetic Irritation

Sympathetic irritation is a condition whereby some pathological lesion of one eye causes an irritation in the other.

Ex- shrunken globe, with enucleation where a portion of the eye tissue such as a stump of the nerve head has been left behind.

One does not find any characteristic or specific pathology to make this disease entity, but the patient has a definite irritation with photophobia and lacrimation. If one removes the stump of tissue that was left the patient is cured.

However, one rarely sees typical cases of this kined.

It is presumed that an irritation of the nerves is the cause. There are some ophthalmogists who feel that sympathetic irritation precedes sympathetic uveitis.

Sympathetic Uveitis

This differs from sympathetic irritation. It has a definite pathology.

Etiology

Sympathetic seems to be produced by injury to the uveal tissue. The injury may be brought about b foreign body, by injuring the eye, and by operation. It may be brought about by malignant melanoma and some have claimed origin without any uveal injury. i.e. spontaneous origin. However, this is not awfully convincing. Sometimes, people have injuries and they do not know it or forget about it. We have seen people in the clinic who say they have had no injury yet have found a foreign body in the eye.

In the Civil War sympathetic uveitis was extremely common.

In the Spanish War sympathetic uveitis was rather common.

In the World War there was practically no sympathetic uveitis. Greenwood felt that the reason was due to the fact that most every eye that had an injury was enucleated as soon as the soldiers could reach a hospital. They did enucleations so promptly that infection did not start.

Meller- is finding tubercle bacilli in blood cultures from patients with sympathetic.

This disease involves the entire uveal tract. It is claimed that in the inner ear, organ of Corti, there is uveal tissue. This is used to explain deafness in association with sympathetic uveitis.

The microscopic picture of sympathetic uveitis is lymphocytes, epithelioid cells, and giant cells infiltrating the uveal tract. Although this infiltration appears in nodules it is diffusely spread over the uvea. Necrosis in the lesions is not a part of sympathetic uveitis. The amount of infiltration may be very slight or diffuse with marked thickening of the uvea. It may be limited chiefly to one segment of the uveal tract i.e. anterior pr posterior.

The microscopic picture contains the essentials of tuberculous inflammation but in tuberculosis, necrosis, fibrosis, and very definite nodular formations are characteristic.

There is no way we can tell about the type of injury to the uveal tissue that is likely to prove it will give sympathetic uveitis.

Bull- said that injury to the ciliary body was much more prone to give sympathetic uveitis, but we do not feel he has or could have studied a large enough number of cases to draw any conclusions.

In the Infirmary there have been only 60 cases that have been studied by Verhoeff in the thirty-seven years that he has been here. One does not receive many cases at one time and there is such a lapse of time between the cases one cannot remember keenly enough all the details accurately to make a comparison.

How do we know we have sympathetic uveitis?

The diagnosis of sympathetic uveitis is an opinion until the eye is examined. Suppose a number of doctors examine an eye and agree that the patient has sympathetic. The patient is treated with convalescent serum and the patient is cured and a paper is written. This actually occurrred but the unfortunate thing was that some 17 years later the patient returned with a flare up. It was then found the patient had tuberculosis with caseation. Thus, the patient really had a bilateral tuberculosis and not sympathetic.

How do we know sympathetic uveitis is a disease entity?

Work of Fuchs-

He decided this was a disease entity of some kind. Some doctors did not agree with him. Fuchs then examined slides of injured eyes and indicated which should have bilateral uveitis (i.e. sympathetic uveitis). In studying over 100 cases he only made one mistake. That alone proved there was a disease entity.

There are two movements to solve the etiology of this disease.

(1) Opinion of Vonszily and Gifford.

Their idea is that it is infection with a virus, a virus that we do not know. The virus might act something like herpes simplex for the reason that herpes simplex can be injected in the chroid and it will travel up the nerve to the other eye and that eye will get a herpes simplex. Thus it shows that you can introduce an infection into the uveal tissue and it can go around the optic chiasm to the other eye. They do not say that herpes simplex does not cause sympathetic uveitis. It is reasonable to consider sympathetic uveitis to be an infection. Stains and cultural methods have been used to find this growing. More than one observer has taken material from uveal tissue of a person and put it in another person's eye without producing sympathetic uveitis

(2) Work of Elschnich and Wood

They advocate anaphylaxis as a cause. Something happens to the uveal tissue and one gets an anaphylactic reaction.

Wood sensitized a rabbit to dog uveal tissue or vice versa.

Also, Wood took blood from patients having sympathetic uveitis and did a complement fixation test. If the test was positive the patient was presumed to have sympathetic uveitis. The test is very complicated and is rarely done. Materials for this test- obtains uveal pigment from the uveal tissue by putting choroid in a strong acid or alkali to digest the tissue. This is ground with a mortar and pestle, and washed to get a pigment suspension. There must be thousands of other things besides just the pigment. Does he know that he has a pure melanin? We do not know the chemical formula for melanin. It is a stable compound.

Woods has made skin tests with this uveal extract. He finds the skin tests are positive with patients having sympathetic uveitis. Verhoeff tried this but was unsuccessful. Woods says you must use fresh material.

Friedenwald- asks what is our criteria for saying that we have anaphylaxis. He claims if we inject material and a person reacts we should be able to remove the skin and find a reaction in the tissue similar to uveitis in the eye. He has found a reaction in the tissue. The reaction, however, may be just a reaction to foreign body or material on the skin or it may be an allergy but we do not really know.

Verhoeff- compromises by saying maybe the cause has to be both an allergic condition plus a virus infection that gives this disease.

Treatment

No single case has occurred sooner than after 13 days of time of injury.

Prophylactic enucleation is very important.

If the vision is lost with injury to uveal tissue it is best to remove the eye.

It is of questionable value to remove the injured eye after the advent of sympathetic uveitis since the disease in the sympathizing eye is not necessarily made less severe and since ultimately there may be better vision in the injured than in the uninjured eye.

Pigmentation-

This does not seem to be a factor in etiology for we have seen sympathetic uveitis in people of all nationalities. Have seen it in people of all pigmentation except albinos. It would be interesting to know if albinos can have sympathetic uveities then we might be able to find out if melanin was included in sympathetic uveitis has been present in any animal although one doctor who has done quite a good deal of work on animals claims he has seen it in horses.

Use of atropin-use this or something else to keep the pupil dilated as long as you see any inflammatory process.

General treatment-

sunbaths, use of salicylates, sometimes aspirin

Theobald gives calcium glucinate by mouth or with a hypo.

Use of foreign proteins- the foreign protein one uses depends upon one's choice. Some use diptheria antitoxin- Verhoeff believes this to be of value. Some use typhoid intravenously or intramuscularly. Milk can be used. Some have used malaria.

Emetine- Verhoeff.

Mycosis of the Choroid

There are organisms in the exudate. The person had a widespread uveitis which occurrred in both eyes following cataract extraction. There are only two cases at the Infirmary, one seemed to be spontaneous and looked something like sympathetic uveitis. Mycosis can come after operation and infection.

Retina

Pathology-

Cystic changes of the retina-

1. Cystoid spaces commonly occur in the retina in the adult although at times they may even occur in the child. They may coalesce together and if so makes the retina usually weak. These changes in even normal eyes are consistent with good vision unless the macula is involved. Cystoid spaces can involve the macula and probably precede formation of a hole in the macula.

2. Cysts in the retina occur as a part of degenerative change following separation of retina.

Separation of retina

There are two general types: the more rare and more easily understood is that separation resultant from transudate or exudate under the retina as a part of the changes with tumor formation, with inflammation as retinitis with massive exudation, or with such general conditions as toxemia of pregnancy. The other type of separation is that which is usually associated with hole in the retina, they type that is amenable to operative treatment is more difficult to understand etiologically.

Usually the retina separates if a real hole is present. Fluid from vitreous goes through the hole allowing the retina to separate. The etiology of the hole is of great importance. The hole may rarely be result of direct trauma, it may also result from advanced cystoid changes in the retina, and it may result , as Lindner contends, from a series of events more or less in the following order, (1) unusual adherence of retina and vitreous, (2) shrinkage of vitreous, (3) Sudden pull on retina by changes in position or tension in vitreous such as results from rapid rotation of the eye or jar of eye transmitted to vitreous, (4) This tears a hole in retina, a type of hole Lindner calls "flap hole". (5) a small piece of retina adheres to shrunken vitreous. Lindner feels that this process must start early in life since hter in life vitreous tends to become fluid. He feels that the etiology may lie in a mild cyclitis especially involving the pars plana of the ciliary body- (i.e. the base of the vitreous).

Holes in retina may also occur secondary to separation but they are round holes. Whatever the cause of the primary hole- closure of that hole early and complete gives cures.

Albinism-

Albinos have no pigment in the pigment epithelium of the retina. The eye receives light from the sides as well as through the pupil Because of the dazzling produced by bright light these people like to stay indoors in the daytime. Can give them some improvement with contact glass which is opaque except for the pupillary opening. This improves vision sometimes but of course has no effect on the nystagmus which is frequently present.

Albuminuric retinitis-

This is a very bad term. This condition is not an inflammation. We could use the term "retinosis" as we use nephrosis. It is not necessarily associated with albumin in the urine or arteriosclerosis but in people with increased blood pressure, that is, having an essential hypertension, also rarely in association with brain tumors. It has a very bad prognosis. Usually when one sees this condition one knows the patient will die within a year or so. The exudate takes on a stellate appearance around the macula. The nerve fibers tend to direct the deposit of this exudation. The exudate occurs in Henle's layer of the retina. Henle's layer is that layer of synapses between the inner and outer nuclear layers. The stellate arrangement naturally results from exudate between the fibers which run more or less radially in direction of the fovea. It shows up more definitely in the macular region than elsewhere.

Retinitis in Diabetes-

There is something that appears like exudate in the retina at times in association with diabetes. This is not the direct result of diabetes but is due to the arteriosclerosis that accompanies the upset of the carbohydrate metabolism. It is probably due more to arteriosclerosis than diabetes. We have reasons to believe that this white material in the retina is hemorrhage that has lost its pigment rather than exudate since in one instance this is known to be the case.

Circinate Retinitis-

This usually affects only one eye. Frequently, one sees this disease associated with Paget's disease. There is an exudate in the retina more or less surrounding the macula. It is irregular and rounded in a circinate manner. It is yellowish white in color. The nature of this exudate has been determined. It is composed of lipoid material no doubt degenerative in source due to retinal changes from vascular embarrassment due to arteriosclerosis.

Retinitis with Massive Exudation or Coates Disease-

Von Hipple's disease and Lindau's disease though they may ultimately result in an appearance similar to Coates disease are essentially angiomatosis retinae. There is a tumor formation in the retina characteristic of hemangioma formation pure and simple. With this new vessels are formed usually producing abnormal

arteriovenous communications, aneurysmal dilitations in the arteries and marked dilication of veins in this region. This retinal lesion may be associated with angiomatous cyst in central nervous tissue, especially in cerebellum.

Retinitis Pigmentosa

There is the appearance of bone corpuscle shaped pigment out near the periphery of the retina and the nerve head has a peculiar waxy yellowish color. The blood vessels look very small. The patient has a disturbance of vision first as night blindness and later as cones also are affected general decrease in vision. Rods and later cones disappear as this is the important pathological change in this disease. Some thought that this disease was due to a sclerosis of the choroidal blood vessels but the choroid in retinitis pigmentosa is perfectly normal. Retinitis pigmentosa gives rise to disturbance fairly early in life and by the time a person is adult he is usually almost blind. The process starts usually at the equator and continues forward and back.

(It is interesting to note in diseases of the retina that there is no disease giving rise to a disease of the nuclear layers of the retina. We have the ganglion cell layer diseased by glaucoma and other things and the layer of receptors by this condition.)

Pigmentation in this disease-there is a degeneration of the pigment epithelium and the pigment grows into the retina and is carried by phagocytes to the small venules thereby taking the shape of a bone corpuscle. Can rationalize from this that must have a disturbance of the pigment epithelium of the retina. Syphilis does give this appearance at times. If one finds what seems to be retinitis pigmentosa in people 40-45 years of age it is usually due to syphilis.

The attenuated blood vessels in this disease may not be attentuated but just look as if they were. There is a great deal of gliosis of the retina. The lumen of the blood vessels may be just as big as ever but the vessels have a larger thicker wall. Any wall that is made thicker is less transparent so that one sees a smaller column of blood in the vessels but actually there may be just as much blood flowing through.

In retinitis pigmenotsa the optic nerve shows no real atrophy. The optic nerve fibers are normal but the yellow appearance is due to a layer of glial tissue over the disc.

Retinitis punctata albescens-

Retinitis pigmentosa can occur without any pigmentary disturbances in the eye but with little white spots in the eye. Retinitis pigmentosa is hereditary and is more liable to affect the males. The retinitis punctata albescens may, however, affect the females.

Retinitis pigmentosasine pigmentosa-

Have retinitis but no pigmentary disturbances.

Retinitis Proliferens-

This condition results from organization of hemorrhage into the vitreous. With this organization one has strands anchored into the vitreous which pulls the retina off as it contracts. Retinitis proliferens occurs rather rarely. It occurs with a rather large hemorrhage that sticks out into the vitreous and is attached to the retina. In retinitis proliferens the connective tissue from the blood vessel walls grow in and produce this organization. As the contraction of the vitreous continues the retina is pulled off more and more. This fits in somewhat with Lindner's theory of separated retina.

Sometimes, the hemorrhages clear up other times, the hemorrhages give white spots and then clear up. Hemorrhage may rarely destroy the macula.

Age of the hemorrhage may be told by its shape.

Flamed shape-the hemorrhage is in the nerve fiber layer.

Round shape-the hemorrhage is deeper layers

Dark and indefinite -the hemorrhage is probably behind the retina or in the choroid.

Straight line above and globular below- when the hemorrhage is in front of the retina. This is your sub-hyaloid or pre-retinal hemorrhage.

Moore's Medical Ophthalmology-

He discusses retinal hemorrhages very well and has some interesting pictures.

<u>Cause of Retinal Hemorrhages</u>

1. From contusion of the eye with or without chemotic retinae and foreign bodies.

2. Perforating wound-trauma.

3. Spontaneous hemorrhage associated with disease of blood vessels, bleeders and people with leukemia, etc.

Retinal hemorrhages will come with any obstruction to the central retinal vein or any branches of the central retinal vein. Be sure to consider what area of the retina is involved. If you have arterial blockage and veins bringing in a little blood may later get small hemorrhages. With venous blockage you will frequently get edema of the retina. Sometimes the edema is so great the retina will swell up over the blood vessels so you can hardly see them. Edema makes the retina look opaque or smokey in appearance.

In leukemia the hemorrhage often has a white spot in its center. The white spot in the center of the hemorrhage is due to an accumulation of leukemic cells that have collected in the center of the hemorrhage. This is rather characteristic. They tend to be yellowish instead of red due to anemia.

Lipemia retinalis results when blood fats are elevated. The blood vessels look yellow.

Macula

There are many different lesions of the macula, the nature of which is not always completely understood.

First mention should be made of amblyopia ex anopsia a condition of faulty macular function with no ophthalmoscopic evidence of pathology. Do not make this diagnosis except as a last resort because some of the patients who appear to have this condition can be given good vision by careful refraction. This is particularly true if mixed astigmatism is present. In true amblyopia ex anopsia it is presumed that there is no pathologic condition in the macula.

Cystic changes in macula have already been mentioned. Reese believes these changes are prone to occur after separation of the retina involving the macula. Cystic changes in macula may result in that condition called hole in macula. Actually there may still be a thin membrane of neurolgia present or we should have a separation of the retina if the hole is completely through. This hole in the macula usually appears quite round as if the retina were removed by a trephine blade. The hole appears redder than the remainder of the retina but not quite cherry red of the cherry red spot in macula. In fact, it was thought that the cherry red spot in the macula did represent a hole in case of amaurotic family idiocy.

Cherry red spot of the macula, however, is due to no change in color of the macula itself but due to opaque changes in the retina around this area so that by contrast the macula appears cherry red. Opaque changes around this area result in amaurotic family idiocy due to degenerative changes in the ganglion cells of the retina identical with the changes in the ganglion cells of the brain.

The cherry red spot of the macula occurring as a part of the blockage of the central retinal artery is also due to opaque changes in the retina around this region, in this case resultant from the anemia.

Thus, the cherry red color is the normal color of the macula but the color of the fundus near by is the same so that the cherry red appearance results only from the opaque changes in the retina near this area. Remember that the fovea is free from all retinal vessels and all ganglion cells so there is relaitvely little or no tissue capable of becoming opaque unless exudation occurs.

With blockage of central retinal artery use all treatment which tends to widen arterial lumen in order that an embolus would pass further along the vessel possibly far enough to open a branch of the vessel and restore at least visual function of the retina supplied by this branch. This dilitation of the artery may be accomplished by use of amyl nitrite and reduction of intraocular pressure by paracentesis. Remember, however, that the retinal vessel may be obliterated by atherosclerosis in which instance attempts to widen lumen would have little or no effect.

Blockage of retinal artery or branch may give appearance of beading of vessel.

Spasm of artery may also occur. If the closure of the vessel is for several hours there is little hope that normal retinal function will return if the circulation is restored since certain retinal elements are already dead.

The macula frequently undergoes degenerative changes characterized by drusen formation, by pigment invasion and by other less understood pathological processes. These changes may be senile, are often bilateral. Other macular changes may be hereditary in character and occur in children.

Lloyd- Hereditary Macular Degeneration
Trans. Am. Ophth. Soc. 33: p. 146, '35
Amer. Jour. Ophth. 19:, p. 216, Mar. '36

Disciform Degeneration of the Macula-

See article by A. R. Kahler and C. S. O'Brien
Arch. of Ophth. Vol. 12, 1935, pages 937-959

This must be differentiated from tumor. From the clinical appearance of this disease we do not know the cause. From the microscope we understand it better.

1. There is proliferation of pigment epithelium of the retina giving fibrous tissue which is somewhat hyalinized. It can also come from a subretinal hemorrhage which disorganizes.

2. This sort of thing gives rise to a central scotoma because the macular function is destroyed. (Figure 19)

Vitreous

The vitreous is more or less a gel. If vitreous is taken from the eye and an artificial vitreous is injected this acts like a foreign body and gives marked disturbance to the eye. This vitreous divides into two parts when put on filter paper, the residual protein and the mucoprotein. The umbilical cord contains mucoprotein and is more or less transparent. There is mucoprotein in the vitreous, in the lens and in the cornea. The mucoprotein probably helps keep these parts transparent. In the embryo one finds mucoprotein. Except in the lens, cornea, and the vitreous it is lost in the adult. It is therefore thought that this is a factor that maintains the transparency of these parts.

Structure of the Vitreous-

The vitreous has a definite structure that can be made out by means of an ultramicroscope. It can be deduced by certain physical and pathological occurrences.

Friedenwald- used an ultramicroscope of higher magnification than Duke Elder and found certain definite arrangement of the vitreous in sheets.

Lindner- also came to this conclusion. He found sheet-like arrangments around the hyaloid canal.

A portion of the vitreous in contact with the pars plana of the ciliary body. This is called the base of the vitreous. It is attached more firmly here than anywhere else.

Another proof that the vitreous has some structure- if you get chemicals that make air bubbles in the vitreous you will find that the air bubbles line up in a certain way showing it is easier to separate the vitreous in one place more than in others. Cloquet's canal can be filled or dissected open by pus or hemorrhage.

Much aqueous or aqueous-like fluid is in the vitreous. The vitreous may be able to imbibe more aqueous or allow a reduction in amount of aqueous.

The hyaloid membrane apparently is a surface condensation of the vitreous. When vitreous pours out of a wound then one has the broken hyaloid membrane.

After cataract extraction sometimes one gets vitreous in the anterior chamber but it does not necessarily mean that the hyaloid membrane is broken. If there is vitreous in the anterior chamber the patient is probably more prone to get glaucoma. Whenever vitreous is lost the vision is less liable to be as good, ordinarily, although cases have been seen where vitreous is lost and the vision is normal, but theoretically it is bad to have vitreous loss or vitreous in the anterior chamber.

In myopia or buphthalmos the vitreous does not grow but tends to break down or hangs at its base. Aqueous gets in and tends to fill up the space. This process of aqueous going through the vitreous according to Lindner can destroy the vitreous and give total fluidity of the vitreous. This is what may happen in cases of buphthalmos- progressive myopia.

The vitreous tends toward fluidity with age.

Diseases of the Vitreous-

Asteriod hyalitis-

This gives the appearance of little snowballs. Under the microscope one sees that there is white amorphous material. Chemically, they are saponified fat. Find this in people having arteriosclerosis. It may be a fatty degeneration or fatty infiltration which saponfies. Sometimes one gets asteroid bodies into the anterior chamber. If one sees them moving about radially in all directions it shows that the vitreous is fluid or partially fluid. Sometimes, the vitreous is so loaded with these that you can hardly see the retina, but the patient may have 20/20 vision. Rarely is this condition bilateral.

Synchysia Scintillans- These are cholesterin crystals.

Other Opacities of the Vitreous

a. Sometimes see congenital remains of hyaloid artery and fibrovascular system of lens.
b..Opacities from hemorrhages and exudates.
c. Clumps of inflammatory cells from uveitis or retinitis.

Dr. Derby always said that the most common cause of blurred nerve head was vitreous opacities. To look for this put on a plus 5 and get focus at different depths-frequently find dust-like vitreous opacities.

Figure 20

Optic Nerve

Anatomy-

The lamina cribrosa is the weakest part of the eye. With a difference in pressure the lamina cribrosa is pulled forward or back. Myelinization of the nerve should stop at the lamina cribrosa. The central retinal vessels are supported by central connective tissue strands. A physiological cupping of the optic nerve is very common and may vary greatly. At times the physiological cupping may resemble glaucoma cupping although a physiological cup rarely reaches the very edge of the nerve head.

Origin- The optic nerve has its origin from the synapses with fibers from the internal nuclear layer of the retina. The cell body is the ganglion cell layer of the retina.

The optic nerve has fibers going to the papillo-macular bundle. Near the region where the optic nerve enters the eye the macular bundle of fibers is in the center but further back in the nerve outside the eye this bundle is at one side of the nerve. The dura and pia arachnoid are carried from the brain down to the eye. The subarachnoid space around the nerve is called the intravaginal space. Anything that disturbs pressure in the brain is going to be transmitted down to the intervaginal space from the brain. The intravaginal space brings cerebrospinal fluid down to the eye. Thus, meningitis can follow enucleation. Also, when evisceration is done there is still some danger of meningitis from endophthalmitis.

Toxic Amblyopia-

Acute and chronic type.

The acute comes from wood alcohol, thallium acetate which is a drug once used in dipilatory creams, quinine, arsenic, nitrobenzol, oil of wintergreen, osmic acid, naphthaline, potassium chlorate, and dynamite fumes.

With the rapid strides in the chemical manufacturing industry there may be other unknown dangers especially from things that are very volatile. Therefore, if you have a patient with toxic amblyopia investigate their occupation.

Acute Toxic Amblyopia

There is not much you can do about it. Some of the nerve fibers are dead and will never recover. If the nerve fibers are only sick there is a chance they will recover. But you have to remove the cause before the nerve fibers are dead.

Chronic Toxic Amblyopia

On the basis of the chronic type there is a great deal we can do about it. Usually this condition is bilateral. First thing they lose is color vision. Lose, green then red, then blue. If the color vision is gone the visual acuity is also affected. The most sensitive test is color and the next most sensitive test is for visual acuity. If you cannot find any other cause the diagnosis is toxic amblyopia or retrobulbar neuritis.

Sometimes a patient has pain when moving the eye. Toxic amblyopia may affect the optic nerve behind the eye. If you remove the cause the patient has recovery provided the fibers are toxic not dead. It takes 4-6 weeks for the optic nerve to atrophy.

For some time the disease called tobacco amblyopia was thought to have its origin in poisons from tobacco in certain hypersensitive or susceptible people. Most always these people were users of alcohol to excess. The large number of calories brought in by the alcohol make it unnecessary to eat so much. The digestion is upset and the patient suffers vitamin B_2 deficiency, develops mild pellagra often with characteristic dermatitis and the "tobacco" amblyopia is more probably due to lack of vitamin B_2 just as "alcoholic" neuritis is presumed to be a peripheral neuritis due to vitamin B deficiency. Frank Carroll makes this suggestion and has reported recovery in people when they take vitamin B and drink and smoke as usual.

Retrobulbar Neuritis

This can be a toxic amblyopia. Cannot always see the inflammation but when the eye turns or is pressed it hurts the patient. That is the only way you can diagnose it. This occurs in multiple sclerosis and may be the only clinical evidence. The vision may return to normal only to recur later with the characteristic peculiar gait, and staccato of the voice. Multpile sclerosis is characterized by demyelinization of the nerves. The myelin sheath may regenerate and the patient may recover for a whil but it can recur again and again.

Think it is a little overdrawn to say that the sinuses can cause this condition by direct extension because to involve the nerve locally the toxins would have to go through the dura, the spinal fluid to enter the nerve.

Edema of the Optic Nerve- Papilloedema or choked disc.

There are two types (1) inflammatory such as optic neuritis
(2) non-inflammatory papilloedema.

In papilloedema the lamina cribrosa is convex toward the vitreous or goes straight across the nerve instead of being slightly concave toward the vitreous. The exact process is not fully understood. The vein in the intravaginal space may be obliterated. Verhoeff's theory is that it is due to more pressure behind the eye than in the eye. If the eye pressure is acute, subnormal papilloedema may result. Some question this. However, certainly a difference in pressure will give glaucomatous cupping.

If papilloedema is caused by constriction of central retinalvein as it crosses subarachnoid space why doesn't papilloedema occur with obsturction of the central retinal vein?

Some say that it does and that the retina is edematous too but in that instance one does not see the difference in the swelling of the nerve head and the retina.

Lauber-measures the venous pressure in the eye. The venous pressure in the eye has to be above the pressure in the intravaginal space in order for the vein to carry off blood. He has made an instrument to take the measurements of the intraocular diastolic venous pressure. While looking at the retinal veins with an ophthalmoscope he presses the instrument on one side of the sclera until he sees a pulsation of the retinal vein and again until venous pulsation is obliterated. The first reading represents diastolic pressure and the second systolic.

It is necessary also to obtain a tonometric reading of the eye which is added to the reading of the monometer. With this he can calculate the venous pressure of the retina with only .5% error. This diastolic venous pressure he says represents intracranial pressure.

With tumor or increase in the density of the orbit as in exophthalmic goiter one gets papilloedema but that does not raise the intracranial pressure. The tumor may press and raise the pressure in the intravaginal space.

Papilloedema

Causes:

1. Increased intracranial pressure.

Parker has shown that difference in the amount of papilloedema in the two eyes is usually due to difference in the pressure of the eyes. The lower the pressure in the eye the higher the papilloedema and vice versa.

Increased intracranial pressure may be due to tumor, hydrocephalus, hydrocephalus (acquired), or it may be associated with nephritis and high blood pressure.

2. Increased intraorbital pressure

Anything that increases the amount of material in the orbit.

3. Decreased intraocular pressure.

There may be some doubt about this however.

Dr. Terry has not observed patients with leaking wound and low tension eye having papilloedema.

Papilloedema if persistent long enough will give rise to optic atrophy and blindness.

Papillitis-

This is anotheredema of the nerve head but the edema is only a part of a real inflammatory reaction.

In both papilloedema and papillitis have a swelled nerve head.

1. papilloedema-passive congestive edema
2. papillitis-inflammation

The papillitis may be due to syphilis, tuberculosis or non-specific.

Atrophy of Optic Nerve

Two forms:

(1) So-called primary or simple atrophy. It is characterized by a perfectly snow white nerve head. This appearance can be:

(1) Syphilis; paresis or tabes or cerebrospinal syphilis in general. (2) by something that breaks the continuity of the nerve-injuries, fractures and etc.

(2) Secondary optic atrophy-

The nerve head appears a dirty white or yellow white. In primary optic atrophy the nerve fibers are destroyed and one sees the lamina cribrosa. In secondary atrophy there is a reaction of the tissue giving rise to repair by gliosis. The tiny capillaries that nourish the gliál tissue give the dirty white appearance or yellowish appearance.

There is a time factor in optic atrophy. It takes 3-6 weeks to show itself ophthalmoscopically after the nerve is severed.

If one has optic atrophy in a blind eye will get no pupillary response. When one sees pupillary response and a blind eye hysteria is probably the cause of poor vision.

Optic neuritis is first. It is an inflammatory change. Then the perineuritis extends and finally destroys the myelin sheaths and axis cylinders.

Other Changes in the Nerve Head-

Myopia Figure 21

Supertraction of the nerve head occurs in myopia. When the eye gets too long the portion of the eye that increases the most in length is on the temporal side especially with developement of a posterior staphyloma. This results in the supertraction since the retina cannot grow and can stretch very little.

Glaucoma and Glaucoma Operations-

It has been said that glaucoma "after the age of forty-five becomes the most important cause of blindness. Untreated glaucoma always leads to blindness". But glaucoma may occur at any age and we as ophthalmologists must be on the constant outlook for this disease in all of its phases and at all ages.

Glaucoma, the symptom complex commonly defined as abnormally high intraocular pressure is something alive, changeable, progressive. It gives rise to numerous complications and sequelae. Attempts are made to catalogue its multiform appearance by means of overlapping, evergrowing and never complete classification.

Etiology

Abnormally high intraocular pressure is due to a relative increase in volume of the eye. But just what brings about such an increase in volume is not fully known.

First, how is normal intraocular pressure maintained?

Intraocular pressure is maintained basically by blood pressure. Intraocular pressure does not remain constant but varies with the heart beat some 1-2 millimeters of mercury and with respiration varies about 5 millimeters. After enucleation the eye pressure falls immediately. However, it is obvious from clinical observations that high blood pressure does not produce abnormal elevation of eye pressure. However, intraocular pressure is influenced by other variable factors which can be summed up into four general groups; (1) osmosis, (2) ionization, (3) hydrostatic pressure, and (4) movements of eye muscles and lids. Figure 22.

We see why hypotony accompanies diabetic coma, (Waite and Beetham observed one case of negative pressure with a collapsed cornea in one case of diabetic coma) why increase in osmotic pressure of blood by injections of hypertonic solutions of sugar or salt or even by administering salt by mouth lowers intraocular pressure.

The maintenance of intraocular pressure has been explained by assuming that the capillary blood pressure in the ciliary body is at a higher level than the capillary blood pressure of the vessels directly connected with Schlemm's canal. A blockage in the venous drainage of the ciliary body as a result of phlebosclerosis is claimed to produce a higher capillary pressure than normal with a resultant overproduction of aqueous. Experimental obstruction of the vortex veins produces a temporary glaucoma. Chronic inflammation around the vortex veins has been observed in microscopic studies of human glaucomatous eyes.

Other observers consider an alteration in the permeability of the ciliary body to be the cause. Glaucoma may be due to a histamine like substance elaborated in the eye.

A blockage of the iris angle produces an abnormally high intraocular pressure. When glaucoma does result from just such an obvious blockage one usually considers the disease a secondary glaucoma. Examples of this are seen in untreated perforating wounds of the cornea with prolapse of the iris, in dislocation of the lens into the anterior chamber, in iris bombe, and in unusually large growth or swelling of the lens, failure of formation of filtration angle, or congenital glaucoma and ruptured Morgagnian cataract, and the growth of epithelium in the anterior chamber. Glaucoma may be produced experimentally by injection of various materials into the anterior chamber, or sometimes by accidents which introduce hemorrhage or vitreous into the anterior chamber.

Just which factor, or just which combination of factors actually do upset the balance that results in glaucoma is still unknown. It has not been proven that sclerosis of the ligamentum pectinatum is not the very first cause. If sclerosis of the ligamentum pectinatum is the cause of primary glaucoma one is at a loss to explain why such sclerosis should occur. I feel that the etiology cannot be explained on the basis of a single factor excepting those conditions that produce blockage of the filtration angle. There must be a definite underlying etiological factor- a condition of pre-glaucoma- which awaits an exciting cause to produce glaucoma. The use of a mydriatic especially if prolonged, a great emotional disturbance, an upset of the metabolism of the eye, as by hemorrhagic retinitis, all may be at times exciting causes. (Figure 23)

Morbid Anatomy

1. Filtration angle

In each of the 1043 cases of glaucoma studied in microscopic section at the Pathology Laboratory of the Massachusetts Eye and Ear Infirmary there has been some pathological change in the filtration angle. This pathology frequently is an anterior peripheral synechia. It may be a sclerosis or fibrosis of the ligamentum pectinatum. Schlemm's canal may be partially or even completely obliterated. The synechia may have been broken down sometimes with hemorrhage in the angle. The hemorrhage may have caused or may have resulted from this synechia break. Although the synechia may be broken down spontaneously, the ligamentum pectinatum remains sclerosed. Therefore, were it possible to free this synechia in glaucoma over an extensive area by operative measure we would not be able to dispel the sclerosis of the angle. Troncoso apparently does not take into consideration the possibility of scleroses of the ligamentum pectinatum in his studies regarding the presence and absence of synechiae in glaucoma.

Optic Nerve

The optic nerve head becomes pathologically cupped because the lamina cribrosa, usually the weakest part of the eye stretches as a result of the increased intraocular pressure. This stretching may be slight, due to unusually strong support of the lamina cribrosa or of central connective tissue strand of the central retinal vessels and their branches or a combination of these. The cupping comes to the very edge of the nerve head though it does not necessarily involve the entire nerve head. In incomplete involvement of the nerve head the part usually involved is temporal. Elliot and later Greenwood has noted nasal cupping first. In view of the work of Roenne, Bjerrum and Siedel, there can be little doubt that the stretching or pulling of the fibers of the nerve head causes the loss of vision and eventual blindness. This is so very important that, with exception to the acute and the so-called malignant forms, one usually has to rely on visual field changes more than any other factor in diagnosing and treating glaucoma. It would seem that any treatment which would relieve the increased pressure would stop all progress of the decreasing visual field and probably allow recovery of those nerve fibers that had ceased function but were still alive. Usually just such sequence does transpire but we are always on the lookout for further deterioration of vision- first as a "shock" from the operation itself, and second, in those cases in which the visual field is slowly wiped out in spite of a successful permanent lowering of the pressure- is the pressure too low? are the stretched nerves accustomed to their stretched position and a return more or less to normal subjects them to further change? does the gliosis of the nerve head secondary to the atrophy and compression destroy other nerve fibers? or as Knapp suggests are we dealing with a progressive atrophy of the optic nerve due to pressure from sclerosis of carotid arteries instead of glaucoma in the first place?

The atrophic nerve head appears yellowish or "dirty" white due to the proliferation of neuroglial tissue on the disc surface. In some instances this proliferation of neuroglia may even fill the cup.

Cavernous atrophy may occur after a lapse of considerable time after death of the nerve fibers. Since cavernous atrophy occurs in conditions other than glaucoma a discussion here is not pertinent to our subject. At times the cup disappears after successful glaucoma operation. At times the central retinal vein is completely obliterated by a proliferation of the intima, a phlebosclerosis; not a thrombosis. This blockage is located in the optic nerve usually immediately behind the lamina cribrosa, at the point where the optic nerve is subjected to the greatest amount of bending or "kinking" when the eye is rotated from the primary position. At times the artery as well as the vein is blocked. If the venous blockage occurs alone or first then a hemorrhagic retinitis results but if the artery is blocked simultaneously with or before the vein is blocked there is no hemorrhagic retinitis. Hemorrhagic retinitis and blockage of central retinal vessels occur secondary to glaucoma as well as before the advent of glaucoma. Where hemorrhagic retinitis precedes the advent of the glaucoma the term hemorrhagic glaucoma is used. Following the blockage of the vessels or vessel collaterals, the small vessels and capillary beds that exist in the optic nerve widen so that the circulation is reëstablished eventually. Dissecting aneurysms may be present in the nerve, these have wrongly been called canalization of the thrombus.

The Cornea

Figure 7

Although the term, steamy cornea, is used at times to refer to edema of the cornea it must be remembered that all steaminess of the cornea is not due to edema. In many instances a steamy cornea is present as a result of an unusually high pressure. This steaminess may completely disappear more or less instantaneously when the intraocular pressure is reduced by operation. Edema of the cornea could not be dispelled so quickly. This steaminess must be due to a stretching of the cornea with probable rearrangement of the corneal lamellae. It seems probable to me that such steaminess could produce halos.

A real corneal edema occurs in certain cases of glaucoma. This condition gives rise to increase of fluid in the corneal stroma and corneal epithelium. In those eyes that have been studied after enucleation it is obvious that there is a disease of the mesenchymal epithelium characterized by irregular staining or by a loss of the so-called endothelium. Von Graefe showed that with the endothelium intact the cornea could withstand a pressure of 200 mm. of mercury without development of corneal edema. But with injury to the endothelium edema readily results. Corneal edema is produced by conditions other than glaucoma- i.e. with inflammations, injuries, and so-called Fuch's epithelial distrophy. Friedenwald feels that the edema with glaucoma of relatively low pressure is due to a vasotoxic substance in the aqueous. The change in the so-called endothelium may be secondary to the bullous keratitis. The changes present in bullous keratitis are:

1. changes in endothelium.
2. edema of corneal stroma and corneal epithelium.
3. increase in number of wandering cells of the cornea.
4. reduplication of Bowman's membrane.
5. bullae under the epithelium
6. edema of epithelioid cells
7. keratinization of the superficial layers of epithelium.

Allen has studied the subject of corneal edema in a detailed manner and feels that the condition will persist until Bowman's membrane is removed surgically since he thinks the disease renders it difficult for the newly formed epithelium to gain a firm attachment to Bowman's membrane after rupture of bullae. Green and others feel that removal of Bowman's membrane does have a very beneficial effect on the condition. Jervey has found however, that the use of insulin is of great value in many cases of bullous keratitis even without an abnormal increase in blood sugar. There is much more to be learned regarding bullous keratitis and its possible close relative, Fuch's epithelial dystrophy.

Pannus Degenerativus and Band Keratitis-

Ultimately the cornea often shows degenerative changes and vascularization in long standing glaucoma. These degenerative changes probably result from poor nutrition of the cornea. Although I have no experimental proof, for a long time I have thought that the cornea obtains some of its nourishment from the aqueous. Certainly, if the aqueous is capable of supplying nourishment to the lens through its capsule it is capable of supplying some nourishment to the cornea through the mesenchymal epithelium and Descemet's membrane. The cornea as a whole must be a semipermeable membrane as is indicated by the passage of atropin, pilocarpine, cocaine, etc. into the aqueous. Therefore, any disease that destroys or markedly injures the ciliary body such as uveitis or long standing glaucoma will alter the nutritive value of the aqueous and might secondarily produce degenerative corneal changes.

Lens-

Increase in size of the lens (as in intumescent cataract or as sometimes follows operative or traumatic rupture of the lens capsule) or changes in its position (as in subluxated or completely dislocated lens especially if into the anterior chamber) may produce glaucoma by mechanical blockage of the filtration angle.

One must also be on the outlook for exfoliation of the lens capsule. One finds amorphous material on the pupillary margin which is probably completely exfoliated lens material. Some observers feel that glaucoma is such a frequent occurrence after this condition that it is a good practice to remove even a clear lens in its capsule when exfoliation is present in an effort to prevent glaucoma.

Complicated cataracts often follow glaucoma. Frequently, one sees rather rapid opacification of the lens after glaucoma operations even when one is rather confident that the lens capsule has not been injured.

Uveal Tract-

a. Iris

Fibrosis of the iris is a very common finding in glaucoma. With the fibrosis the elasticity of the iris would be reduced and the pupillary reactions would become more sluggish. A contraction of this fibrous tissue would shorten the iris giving a more dilated pupil. This contraction, if extensive enough, results in ectorpion uveae. Ectropion uveae adds to the dilitation of the pupil. The fibrosis also interferes with the mobility of the iris.

The iris also becomes atrophic. This atrophy is often characterized by a change in color and by loss in translucency. Atrophy may occur before operation but is also frequently seen after operation especially if a pillar of the iris is caught in the wound and drawn up. This "drawing up" may, however, be the result of stretching of vitreous that has prolapsed into the anterior chamber as suggested by Lindner. Heterochromia iridis, essential atrophy of the iris, and anaridia are almost invariably followed by glaucoma.

A very interesting feature of glaucoma secondary to hemorrhagic retinitis (the so-called hemorrhagic glaucoma), to malignant melona of the choroid, to retinoblastoma (observed in only one case) and to separated retina is the newly formed vascularized membrane of the iris. Samuels attributes this to toxins, and Friedenald to necrosis. Something happens to the iris that stimulates a capillary growth along the outer boundary layer of the iris, it could be toxins, necrosis, or disturbance of circulation to the iris sufficiently that the anterior boundary layer suffers from lack of nutrition. Do not confuse this vascularization with organization of hemorrhage or exudate on the surface of the iris.

Necrosis of the iris occurs in acute glaucoma with high tension. Friedenald feels that it is due to the direct result of pressure sufficient to cause the collapse of capillaries supplying the region affected and occurs when intraocular pressure exceeds capillary pressure in the pupillary portion of the iris.

b. Ciliary body

In acute glaucoma the ciliary body is markedly hyperemic. There may be hemorrhagic, serous and fibrinous extravisations into the ciliary processes. Swelling of the ciliary body and its processes are presumed to be the cause of the shallow anterior chamber, the anterior subluxation of the lens and the obstruction of the filtration angle.

In long standing glaucoma the ciliary processes are often hyalinized. Compression of the ciliary body is a frequent finding as is atrophy of the ciliary muscle. All of these changes indicate that the character and possibly the quantity of the aqueous is altered. A complete destruction of the ciliary processes and their capillaries gives a spontaneous cure of the glaucoma but only after the nerve is atrophic and usually with opacification of the cornea.

c, There are no important characteristic changes of the choroid in glaucoma.

The changes in the retina are essentially a degeneration of the ganglion cells secondary to the death of the nerve fibers at or near the nerve head.

Hemorrhages, sclerosis of retinal vessels, and cystoid degeneration are common findings in glaucoma but not uniform in findings.

Although one would not expect separation of the retina to occur in glaucoma the two conditions do exist together. In fact, glaucoma may be secondary to long standing separation of the retina.

Vitreous-

It is possible that the vitreous may swell by imbibing more fluid and produce glaucoma.

Sclera-

The sclera shows changes in glaucoma especially in the formation of the so-called staphylomata. Progressive myopia and conical cornea may be considered to

be a sort of glaucoma in which the sclera and cornea respectively are unable to withstand more or less normal intraocular pressure.

Glaucoma Operations

1. Paracentesis

This iswonderful operation. One must depend on it to controlthe tension in cases of glaucoma with secondary uveitis or with interstitial keratitis when it is necessary to use atropin instead of pilocarpin. At times a filtering operation is produced as a result of paracentesis if the paracentesis is done under a flap. For that reason, if we desire any prolonged effect it is best to do the paracentesis under a flap. This is a favorite operation with Dr. Verhoeff in cases of congenital glaucoma. He makes a keratome incision in a manner similar to that used in a Reese iridectomy.

2. Posterior sclerotomy

This is at times also an excellent operation. If performed with a cutting instrument it should be done anterior to the ora serrata or we run great danger of separation of the retina later. A more permanent fistula might be obtained by doing the operation, if done posterior to the ora serrata, with diathermy which would tend to prevent separation of the retina later. The effect of this operation is to drain out some vitreous. Since vitreous imbibes a great deal of aqueous, aqueous like fluid can leak from the vitreous. This operation deepens the anterior chmaber and makes it easier to do a filtering operation in case the anterior chamber was extremely shallow. This operation is also of great value in a congestive glaucoma when the patient is dying of some condition such as uremia,etc. It does relieve the pain. It also is of value in those cases where a swollen vitreous seems to be the underlying cause for the glaucoma, i.e. when drainages of the anterior chamber give no reduction of the tension. It is of value in the so-called malignant glaucoma and possibly in hemorrhagic glaucoma. As we see from the illustration it is exceedingly dangerous when an intraocular neoplasm is present.

Is it not highly dangerous to do any type of intraocular operation on a blind eye? Such eyes may and often do contain malignant melanomata. That is sufficient reason to condemn any operation other than enucleation on a painful blind eye.

c. Iridectomy

The good results derived from this operation in acute glaucoma may be only the breaking of a vicious cycle. A filtering cicatrix may be the result especially if the iris is torn at its base and small tags of iris prolapse into the wound producing minute iridotases.

The cut edge of the normal iris shows no evidence of repair other than the sealing of the cut ends of the blood vessels.

It is interesting to note just how impossible it would be to reopen the filtration angle even over a small area. To insert a keratome at the root of the iris when an anterior peripheral synechia is present one would invariably enter the posterior chamber. It is also interesting to consider just how relatively a small area of the filtration angle one could free by means of operation even if such freeing of the angle did reëstablish normal filtration.

Iridectomy where there is an iris bombe or an anterior central synechia if done sufficiently early may cure a secondary glaucoma where the etiology of the glaucoma lies in the synechia.

Peripheral iridectomy-

Filtering operations whether they be trephines, iridotases, iridenclyses, or La Grange operations, if successful the end results are approximately the same. The filtering cicatrix or bleb is not a single large vesicle but consists in "edema" of loose connective tissue. If the iris was included in the wound the iris stroma atrophies and the pigment epithelium of the iris remains, an epithelial structure which maintains an opening between the anterior chamber and the episcleral tissue.

A filtering operation may fail from

1. Fibrosis across the opening from too much trauma-failure to remove all of button, organization of hemorrhage, proliferation of tissue from the vascularized membrane of the iris, formation of cystoid cicatrix, intraocular neoplasm-and possibly a shock to the ciliary body and too low a pressure to maintain filtration,- prolapse of lens into wound, or filling of the anterior chamber with hemorrhage with resultant hematogenous pigmentation of the cornea in some instances.

Expulsive hemorrhages-

With large hemorrhage in the anterior chamber it is possible to avoid hematogenous pigmentation of the cornea by washing out the anterior chamber. Even if the blood has clotted the washing of the anterior chamber and the loosening of the clot alone has stopped the formation of hematogenous pigmentation in two cases.

One of the dreadful complications of any intraocular operations is infection. Although infection rarely occurs at the time of operation or during convalesence, it does occur and we should take the same precautions to prevent such a complication as we do in cataract operations, i.e. smear and culture of the eye before operation, attention to condition of the nasolacrymal drainage system, and proper aseptical measures in preparation for and during the operation. Much more common is the late infection of the filtering cicatrix and "bleb". We see several cases a year in the clinic. They have occurred as a complication of conjunctivitis and occasionally have occurred without any clinical evidence of conjunctivitis. "Pasturization" of the bleb with proper treatment of the conjunctivitis and foreign protein therapy has saved an eye even when a hypopyon was present. In addition to periodic attention to nasolacrymal duct a mild antiseptic for continuous usage is probably the best prophylaxis.

The cyclectomies and cyclodialysis are not condemned by being ignored in this paper. I simply have no pathological specimens of these operations, not necessarily because they are uniformly successful but because they are performed infrequently in the Massachusetts Eye and Ear Infirmary.

Another dreaded complication in any intraocular operation when any part of the uveal tract is injured is sympathetic uveitis. Sympathetic uveitis has occurred after iridectomies, trephines, iridctases, and La Grange operations.

Separation of the choroid is a most frequent complication of glaucoma filtration operations. Since it usually resolves spontaneously it is of no great importance. It can be mistaken for sarcoma of the choroid. However, it transilluminates clearly. It is associated with hypotony of the eye, shallow anterior chamber, excessive filtration or even leakage from the wound. As it resolves the choroid becomes wrinkled. If the separation persists for a while in this state the pigment epithelium of the retina proliferates so that with complete resolution of the detachment typical pigmented streaks are seen.

Exophthalmos

Causes:

(1) The eye may be exophthalmic if there is no tone to the eye muscles to hold it back in place. Anything that would cause paralysis of the extraocular muscles would cause this. Even paralysis or complete tenotomy of one muscle would have some effect.

(2) Pushing the eye out by muscular activity.

Lillie, in a paper on exophthalmos in exophthalmic goiter, concluded that exophthalmos must be due to something that pushes or pulls the eye out of the orbit.

Theory of vestigial muscle that pushes or pulls the eye out of the orbit. He got this effect in laboratory animals with stimulation of the sympathetic nervous system. Adrenalin injection will do this. "Believe it or not" Ripley found a man who had a muscular structure with which he could pop the eye out of the orbit. We know that there is a vestigial muscle in the eye of this kind. It is reasonable to suppose that people have varying vestigial muscles. Some persons have a very large vestigial muscle.

Another argument in favor of this view is that the vestigial muscle be more developed in one orbit than in the other thus accounting for those instances of exophthalmic goiter where only one eye is exophthalmic.

One can have exophthalmic goiter unilaterally. Be sure to remember that there can be an intractable exophthalmos with goiter.

"Malignant" exophthalmos-

These are cases of exophthalmos that in spite of everything that is done the eye is pushed right out of the head.

Naffziger- California

Worked on some of these cases and did an operation through the anterior cranial cavity made a decompression hole down into the orbit to let the orbital material herniate.

Naffziger feels that the trouble here is a marked increase in size of the extraocular muscles. The change in them resembles Zenker's Hyaline Degeneration of the Rectus Abdominalis in Typhoid fever.

(3) Increased orbital content

This includes of course Naffiger's type of exophthalmos given above as well as a long list of neoplasms benign and malignant as well as foreign bodies, aneurysms, inflammation, abscesses, and a peculiar condition called pseudotumor. See classification that follows later.

Pseudotumor is a peculiar tumor like mass which usually has its origin in the orbit. It may project out and be felt as a solid mass. Microscopically it appears as a mass of inflammatory tissue with fatty areas, inflammatory infiltration and thickened blood vessels. It resembles syphilis somewhat but Wasserman is negative. It eventually tends to subside.

Oxycephaly or tower skull- Skull fissures fuse long before they should. Orbits do not develop and eyes lie completely extraorbitally. Optic atrophy ultimately occurs due to increased intracranial pressure.

Pulsating exophthalmos may be due to-

a. Meningocele into orbit.
b. Angioma or very vascular sarcoma in orbit.
c. Abnormal arteriovenous communication commonly called arteriovenous aneurysm.

The abnormal communication may be due to trauma, to congenital defect or to a combination of them. Congenital defects tending toward this condition seem probable due to the fact that the character of the vessels and the circulation change so greatly from early appearance in embryo to adult form. The conditions may also arise from angioma and circoid aneurysms.

An Abnormal arteriovenous communication leads to interesting sequences given briefly as follows:

1. Arteriorsclerosis central to abnormal communication with more work thrown on the heart and consequent hypertrophy of the type seen in pregnancy and in exophthalmic goiter.
2. Artery peripheral to fistula loses some of its muscular wall and tends to resemble a vein more.
3. Veins in vicinity of fistula take on character of arteries due to marked increase in pressure to which they are subjected.
4. Marked widening of all anastamotic trunks, arterial, capillary and venous. In fact it brings out development of anastamotic channels more effectively than any other stimulus.
5. Actual increase in size and number of capillaries in bed of vessels involved due to increased capillary pressure and poor nourishment of part followd by fibrosis and yellowish discoloration.
6. Edema of tissues supplied by involved vessels.
7. Overgrowth of part (especially a limb) if growth is not complete.
8. Showing of heart if fistula can be obstructed digitally.
9. Increase in oxygen content of veins in vicinity of fistula.
10. Murmur usually of blowing or musical character and more or less continuous.
11. Thrill.
12. Abnormal pulsation.
13. The affected area may increase-for instance pulsating exophthalmos may become bilateral.

The condition may be cured by-

1. and best - Proximal and distal ligature of artery and vein with removal of vessels and fistula = Removal of fistula alone or tying vessels may result in recurrence. In most localities this is best done say six months after the fistula was first found in order that good anastamosis is established.
2. If the fistula cannot be attacked directly then ligate chief arterial feeders and venous drainage. If the fistula in the apex of the orbit or in cranial caity, tie the common carotid and jugular vein. If one dsires more strangulation of circulation tie superior thyroid also and still more effective tie external carotid to prevent excessive venous drainage of head. Tie angular vein which prevents much of venous outflow. This alone has given cures but is not so dependable. This ligation should be done relatively early because the longer one waits the better is the collateral circulation and the less likely tying these vessels will slow passage of blood through fistula sufficiently for clot to form. The attempt generally is to try to equalize circulation pressure on two sides of the fistula-then cure naturally results.
3. Removal of eye and tying of all orbital vessels has cured two patients. If the fistula is intraorbital the success of this type of operation is much more probable. It is perhaps the operation of choice if the vision of the eye on the involved side is already destroyed by this or other conditions.
4. Injection of viscous fluids or even inserting muscle emboli into artery is dangerous.

There has been one instance of pulsating exophthalmos when the fistula was carotid-jugular (in the neck). In this instance there must have been small or absence of connections between the intracranial venous sinuses of the two sides

in order to conduct the resultant increased venous pressure and pulse to one more than to the other.

Trichanosis-

The myocitis caused by trichina spiralis which reach the muscles from the blood stream from the intestinal tract after injection of infected pork that has not been thoroughly cooked.

Ingestion of infected meat is followed by diarrhoea. Some two weeks later the larva are in the blood stream and may reach any muscular structure including the heart and even get into cerebrospinal fluid. At this stage there is a fever and an eosinophilia. Often the extraocular muscles and orbicularis oculi are affected with swollen lids, slight redness, swollen extraocular muscles and possibly some pain in rotating eyes.

Treatment at this stage is probably too late.

Meningioma-

This grows slowly is rather a benign tumor of the meninges. When it involves the sheath of the optic nerve and orbit it often is intracranial as well and inoperable. Enlargement of the optic foramen as determined by X ray indicates intracranial involvement. In fact the tumor probably had its origin in the cranium.

True glioma of the optic nerve is a benign tumor. It naturally destroys vision, produces exophthalmos and may also be intracranially. It occurs in rather young individuals.

Exophthalmos

1. Brain lesion
2. Trauma
3. Tenotomies

1. Paralysis or Paresis
2. General Diseases
   - Goiter
   - ? Hypothyroids
3. Vascular Diseases
   - a. Leukemic tumor
   - b. Abnormal arteriovenous communication
   - c. Hemorrhage in orbit
   - d. Blockage of venous outflow
4. Meningocele
   - Mucocele from nasal accessory sinuses
   - Dermoid cyst
   - Microphthalmos
5. Lacrimal adenitis- mumps, Mukulicz, etc.
6. Tumors
   - a. Primary
     - Malignant
       1. Lacrimal gland-mixed tumor
       2. Sarcoma
          - Unpigmented
          - Pigmented
       3. Hemangiendothelioma
       4. Optic nerve
          - a. Glioma
          - b. Meningioma
     - Benign
       1. Lymphangioma
       2. Neurofibroma
   - b. Secondary
     1. Neuroblastoma
     2. Glioma and meningioma
     3. Tumors occurring in leukemia
     4. Sarcoma chiefly from uveae
     5. Carcinoma-probably from nasal accessory sinuses
7. Infection of Orbit
   - Acute-
     - Primary
       - a. abscess
       - b. cellulitis
       - c. [illegible]
     - Secondary
       - a. [illegible]
       - b. nasal accessory sinus infection
       - c. meningitis
   - Chronic-
     1. Pseudotumor
     2. Syphilis
     3. Tuberculosis

The More Common Tumors of the Eye and Adenexa

Lids- Surface
  Papilloma
  Cutaneous horn
  Naevus flammeous = association with angioma of choroid and even Lindau's disease
  Angioma — Hemangioma, Lymphangioma
  Angiosarcoma
  Leiomyoma
Lid Matrix
  Sarcoma
  Myoma
  Neurofibroma
  Paraffinoma
Conjunctiva
  Naevus — pigmented, unpigmented
Limbus
  Carcinoma
  Sarcoma
  Dermoid
Sclera
  Brawny scleritis
Uveal Tract
 Iris
  Myoma
  Malignant melanoma
 Ciliary Body
  Diktyoma
  Adenoma
 Ciliary Body and Choroid
  Malignant melanoma
 Choroid
  Angioma
  Neurofibroma
Melanosis oculi
Diffuse malignant melanoma
 Retina
  Retinoblastoma (not synonymous with glioma)
  Glioma
Optic nerve
  Nerve itself
   Glioma
  Nerve sheath
   Meningioma
Lacrimal gland
  Mixed tumor
  Mikulicz
Orbit
  Sarcoma
  Angioma
  Neurofibroma
  Lipoma
  Paraffinoma

Basal cell carcinoma
Hair matrix carcinoma
Carcinoma adenoides cystica
Epidermoid carcinoma

Dermoid
Teratoid
Sebaceous cyst
Epithelial cyst

Iris cyst
Metastatic carcinoma

Metastatic carcinoma

Angioma (Lindau's disease, von Hippel's disease)

Pseudotumor

Dermoid cyst
Dermoid tumor
Leukemic tumor
Lymphoblastoma
Metastatic carcinoma

Carcinoma of lid so often basal cell, hair matrix or carcinoma adenoides cystica which are only lowly malignant. However, epidermoid carcinomata do occur.

Sarcoma of the lid is much more rare. It usually begins in lid substance and nearly always resembles chalazion at first. If the true nature of the tumor is discovered early it apparently can be cured by conservative surgery or even radiation. However, after the "chalazion" has been curetted before the true diagnosis is established conservative treatment is not sufficient. In one instance a leiomyosarcoma of the lid recurred some five times after local surgery and the patient ultimately died of metastases. The tumor changed its character from original leiomyosarcoma to round cell sarcoma.

Lid papillomata are very frequent. Even cutaneous horns are found. These tumors often are inflamed. Occasionally they contain malignant elements especially in the older people.

Angioma may vary from almost solid tumors in which the cells form capillaries only slightly to large highly vascular growths. The naevus flammeous is frequently accompanied with an angioma of the choroid.

Neuorfibromata of the lids occur. They usually have a peculiar feel like "bag of worms", and etc.

Paraffinoma is a peculiar tumor formation the result of oil in the tissue. This may be from injection of lipoidol into blocked tear passage with sufficient pressure that the material breaks out into the tissues. Characteristically there is a granuloma produced in which giant cells are found. This may result from ruptured sebaceous cysts and even from chalazions.

Conjunctival and epibulbar tumors are of various types.

The naevus is very common it may be pigmented or unpigmented. The naevus cells resemble epithelium somewhat but probably the tumor has its origin from nerve endings. Occasionally one sees a naevus that appears to be malignant.

Carcinoma usually are at the limbus. They shape themselves to the space between the lids and tend to spread over the cornea. However, they have little if any attachment to the cornea. They are of low grade malignancy. If treated early local removal and radiation may suffice.

Sarcoma may exist in the same area. It spreads onto the cornea with firmer attachment.

Dermoids also occur in this region and often involve cornea. They usually look yellow.

One finds teratomatous tumors in this region at times.

Tumors of uveal tract-

There are several reports of myoma of the iris to be found in the literature however other observers feel that these tumors are simply unpigmented melanomas of the iris.

These iris tumors may be single nodules or they may spread out over the surface of the iris producing the so-called ring sarcoma. The tumor may have its origin in the ciliary body and grow into the iris until they can be seen finally through the cornea.

One often sees pigmented spots on the iris that cause no alteration in motility and are not particularly raised. These are called naevi. However, an iris tumor which causes deformity of the pupil when the pupil is dilated or contracted or both is probably a growing neoplasm that would probably destroy the eye and even metastasize. These tumors are lowly malignant. If the iris root is free- determine this by use of pilocarpine and goinoscope- remove the tumor by iridectomy. Spread the iris with the tumor on a piece of paper as smoothly as possible. Let it dry a few seconds- put it into formalin and have a patholgocial study at which time the examiner often can determine if the tumor is completely removed. If the tumor cannot be removed by iridectomy it is possible to remove a piece of sclera and ciliary body out with tumor. This is to be recommended only in case the other eye is blind.

The melanomata of the ciliary body and choroid are more common and we know much more about them than about the iris tumors.

These melanomata of the ciliary body and choroid are the only malignant primary neoplasms of these organs.

Their exact origin is not known. They all have the potentiality of pigmentation as shown by Bloch's dopa reaction and by silver stains. They may originate from chromatophores of the choroid, from muscle, from nerves. Masson feels that all melanin producing cells are of ectodermal origin. For that reason it is best not to call these tumors sarcoma. Melanoma is a better term because it makes no comittment as to the origin of the tumor.

These tumors vary greatly in amount of pigment in them. The amount of pigment seems to have little relation to the degree of malignancy. Pigment is more abundant in the older portions of the tumor and near necrotic areas.

The tumors frequently contain numerous and large blood spaces. In many instances tumor cells are found free in such spaces, however, the flow of blood through these spaces if often very sluggish so tumor cell emboli may not be as common as they appear to be.

The tumors vary greatly in shape. If they break through Bruch's membrane they become pedunculated. After breaking through Bruch's membrane they may invade the retina. It is usual that the retina is adherent to the apex of the tumor whether or not it is actually invaded. This is an important point in diagnosis in that one can see a solid dark mass under the separated retina even in one small area that is almost absolute proof of tumor.

The tumor regardless of size can produce glaucoma. Therefore, suspect tumor in any instance of unilateral glaucoma.

The tumor also, especially when partially necrotic, can produce uveitis. Therefore, suspect tumor in every case of unilateral uveitis.

Separation of the retina likewise is a very common occurrence in tumor. Two instances are known in which operation for separation of retina was done when the cause of separation was tumor. Therefore, transilluminate every case of separated retina and study the entire surface of the retina that can be seen before feeling sure that separation is not due to tumor.

Differential Diagnosis

Tumor (with separated retina)	Separated Retina
1. With tumor not tremulous	1. Tremulous later on. (If you move the eye around you can see it wave and shake).
2. Usually rounded	2. In furrows or hills and valleys
3. No flap hole- only holes found are retina torn from ora if the tumor is at the equator approximately.	3. Flap holes
4. Transilluminates black	4. Transilluminates clear
5. Choroidal structure immediately under separated retina at some point.	5. Usually no pigment but may have pigment mottling from growth of pigment epithelium of retina.
6. Glaucoma early	6. Glaucoma later
7. Uveitis early	7. Uveitis late
8. Blood vessels red	8. Blood vessels black
9. Slit light of ophthalmoscope shows no clear space behind the retina	9. Does show clear space behind retina
10. Hemorrhage	10. No hemorrhage

The tumor may extend from the eye by-

1. Metastasis through the blood stream- usually to the liver.(therefore remove eye as soon as diagnosis is made)

2. Extension along optic nerve

There are two instances in which tumor extended into nerve- not sufficiently long nerve was obtained at enucleation and the patients tumor ultimately extended into brain and destroyed fibers of the optic tract to the chiasm producing hemianopsia of the other eye.

3. Extension outside of eye.

a. Direct erosion of sclera-rare

b. along an emmisarium- very common

c. along operative wound. These eyes are often operated on for glaucoma when presence of tumor is not even suspected.

d. through rupture of globe.

Tumor left in orbit after enucleation appears to cause recurrence in orbit rather rarely as if orbit was unfertile ground for tumor growth.

Cell type and fiber content of tumor.

Only recently Callender of the Army Medical Museum devised a cellular classification of these tumors consisting in:

Spindle-cell type

"Sheets, whorls and other irregular arrangements of spindle shaped cells, with long, oval nuclei. The ends of the cells appear to terminate in fibers, so that the cells resemble fibroblasts,... there is no argentophile reticulum except that accompanying nutrient vessels. These spindle cell tumors can be separated into two divisions by the nuclear characteristics.

Subtype A "... the nucleus has a delicate, reticular structure, in which the nucleolar material is not well defined. These tumors are usually fairly heavily pigmented.

Subtype B "... the cell has a sharply defined, deeply stained, small, round nucleolus, usually situated near the center of the nucleus, in a rather coarse nuclear network. ... are usually lightly pigmented.

Fasciculer type

The cells of this type are elongated, sometimes forming fiber-like structures, but rounded and polygonal shapes are seen. The characteristic nucleus is oval, has a distinct nucleolus, and closely resembles the nucleus of spindle-cell subtype B. The majority of the cells ... are arranged in columns or fasciculi, the long axis of the cell being at right angles to that of the column. The cells radiate about the center of the column in a palisade arrangement, the center being a lymphatic or capillary blood vessel ... Pigmentation is usually very scanty.

Epithelioid type

"... polygonal cells, usually of relatively large size, though there is considerable variation in both size and shape. The nucleus is large, round, or somewhat oval, and the nucleolus is distinct ... Often rather abundant argentophile reticulum is found ... This type varies greatly in the degree of pigmentation.

Mixed-cell type

"... irregular mixtures of spindle and epithelioid types of cell, with occasional areas of fascicular type ... These tumors are usually very heavily pigmented.

Against this he checked the ultimate follow up result of each case to find that there was no death from tumor in Spindle A.; % SpindleB6.8, % deaths Fascicular 21.4, % deaths Epithelioid 25.0, and % Deaths Mixed 36.6.

Dr. Terry working along the same lines derivod somewhat similar findings except Spindle B gave 41.5 % death. Of this work it is evident that Spindle A is a relatively innocent tumor, Spindle B, Fascicular and Epithelioid make up second grade of malignancy and Mixed makes up the greatest degree of malignancy. Still more work must be done on this as the total number of cases so studied is relatively small.

More recently gradation according to argentophilic reticulum is being done also and may have some indication of degree of malignancy also.

A malignant melanoma may be simulated by discifórm degeneration of macula, angioma of chroid, and subchoroidal hemorrhage. However, it seems to me more dangerous to leave an eye,in which one is suspicious that a tumor exists, unenucleated than to remove such an eye. An occasional enucleation of an eye without a tumor is not nearly as terrible a mistake as leaving in the eye containing a tumor

The iris may give origin to a cyst, the cyst having its origin from the pars iridis retinae. This cyst may be attached by a long pedicle and it may even be free in the anterior chamber.

The ciliary body may give rise to so-called adenoma of the ciliary processes or as some call it a hyperplasia of the ciliary epithelium. Usually they are curiosities only found by accident in enucleated eyes. Occasionally, they may become quite large and invade the iris.

The choroid may give rise to an angioma. This often accompanies naevus flammeous of the lids and face. It usually results in glaucoma. The angioma may resemble a malignant melanoma clinically only to lose its engorgement with blood upon enucleation so that when the eye is opened no evidence of tumor is seen grossly. The ture nature of the condition is discovered by microscopic sections.

The choroid also may give origin to neurofibroma and at times is the seat of metastatic carcinoma. The carcinoma appears as a peculiar waxy growth. There is almost invariably carcinomatous involvement of the lung even though the origin of tne tumor is elsewhere. When blood metastasis occurs the carcinoma appears to grow through the lung to reach systemic circulation and the choroid. Of course, in carcinoma of the choroid enucleation is usually of no value since other metastases or the original growth have doomed the patient already

The choroid also may contain naevi or benign melanoma, tumors that do not grow fast if at all and that do not interfere with vision.

Tumors of the retina

Until some eleven years ago the primary malignant neoplasm of the retina was called glioma or neuroepithelioma. Glioma of course refers to a central nervous tissue tumor of glial tissue whereas this retinal tumor is a malignant neoplasm of undifferentiated retinal cells. It is in no way similar to glioma of brain. The best

term for it is retinoblastoma. Recently a true glioma of the retina similar in cellular construction to a glioma of the brain has been found and probably will be reported soon.

Retinoblastoma occurs in infancy or early childhood. It has been discovered even in newborn babies. It is frequently bilateral. It is due to embryonic failure of differentiation of the retina. It is hereditary. The tumor when small looks like snow white nodules in the fundus- when large it forms a mass behind the lens and gives the typical "amaurotic cat eye" appearance. This tumor metastasizes readily to the liver, grows along the optic nerve to the brain, and having gotten into the orbit produces a large unsightly tumor mass. It is very sensitive to radiation.

This tumor does not carry with it a sufficient blood supply. This results in necrosis of tumor some distance away from blood vessels. A characteristic appearance is a cord of living tumor cells (usually staining rather blue) around a blood vessel and further to the periphery the cord is circled by a mass of necrotic tumor cells (usually staining with eosin). Calcareous nodules are frequently encountered. The nodules can be determined by X ray, an aid in diagnosis. The tumor cells frequently attempt to produce rods and cones around a cavity thus producing rosettes. It is surprising that the huge amount of necrosis causes little or no uveitis. In fact, at times one may observe a mass of necrotic tumor cells in the bottom of the anterior chamber like a hypopyon but in an eye free from inflammation.

Although retinoblastoma are almost always found early in life one has been found in a patient past 40 years of age.

Another type of tumor found in the retina is angioma. It gives rise to a tumor mass formation somewhat whitish in color and usually rather circumscribed. In or near this mass arterioles may be seen connecting directly with veins. The arteries supplying this area frequently show aneurysmal dilitations whereas the veins draining the area, due to abnormal arteriovenous communications are greatly distended. When one sees a markedly distended vein in the nerve head follow it out into the periphery of the retina where the angiomatous tumor is present. This condition usually results in separation of the retina and resembles Coates disease. The condition is also Von Hippel's disease and if there is associated lesions of cerebellum or other portions of the central nervous system it may be called Lindau's disease. One must have a careful neurological examination when the retinal lesion is discovered because of the frequency of associated cerebellar tumor.

This angiomatosis is a true angioma of the retina.

Tumors of the optic nerve-

There is only one primary optic nerve tumor. It is a true glioma. It occurs early in life and often becomes as large or larger than the eye thus producing a marked exophthalmos. From examining the specimens it is evident that simple enucleation would remove the eye and leave the tumor behind. The tumor may extend along the nerve into the cranial cavity and may cause enlargement of the optic foramen. The tumor destroys the optic nerve fibers, grows into the intervaginal space after having gotten into the space grows along it. This extension along the space may be further forward than the tumor has extended in the nerve itself. Thus, enucleations in front of the tumor may contain tumor in the intervaginal space only w[illegible] with the optic nerve itself normal. The tumor, if malignant, is malignant only due to location and involvement of the brain.

A tumor of the optic nerve sheath may occur. It is a meningioma. It frequently is intracranial as well as intraorbital and the optic foramen in such instances is almost invariably enlarged.

Tumors of the lacrymal gland are almost identical in type and variety as tumors of the parotid gland.

Tumors of the orbit

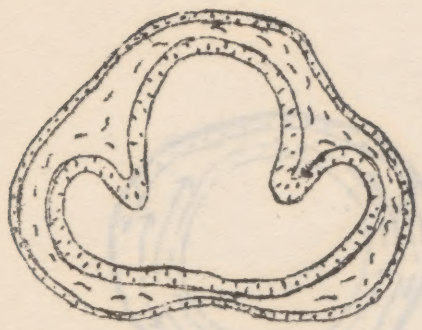
Malignant melanoma can arise in the orbit.

Fibrosarcoma, angioma, neurogibroma, lipoma, teratoid tumors, sebaceous cysts and dermoid cyst are found here.

Tumors from the nasal accessory sinuses and from the nose may extend into the orbit both carcinoma and mucoceles.

Neuroblastoma- This usually starts above the kidneys in the suprarenal region. It occurs in children, is a very bad tumor and metastasizes.

Case of Verhoeff- made the diagnosis of neuroblastoma because he could feel the child's skull. Felt areas of caries, the skull was very soft. He also found nodule in the abdomen. There is absolutely no hope for these patients. Neuroblastoma enters the orbit. It may be they metastasize everywhere in the body. Have had more of these tumors metastasizing in the orbit than any other kind of tumor.



Transverse section of forebrain.
(after Seefelder)
a. Cavity of forebrain.
b. Surface ectoderm.
c. Wall of optic vesicle.
d. Cavity of optic vesicle.

Fig. 1

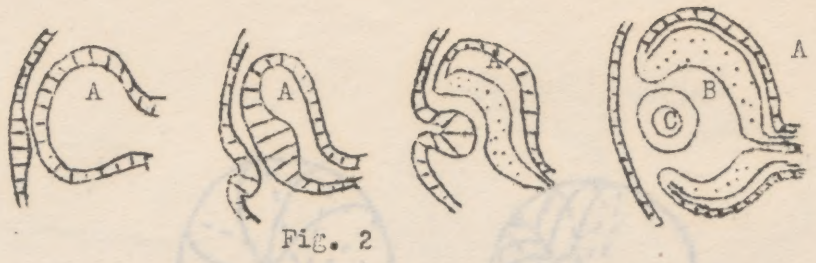


Fig. 2

Scheme showing invagination of optic vesicle, A; with formation of secondary optic vesicle or optic cup, B; and formation of lens vesicle, C. (after Mann) Note that all sections except the last are vertical. The last diagram represents a horizontal section of the adjacent one.

Fig. 3

Scheme showing the development of the lens. (after Mann) A, lens thickening. B, lens pit. C, lens pit closing. D, lens vesicle. E, elongation of the cells of posterior wall of lens vesicle. F, obliteration of lens vesicle cavity by cells of posterior wall. G, formation of lens sutures by the meeting of fibers which are developed in the equatorial region.

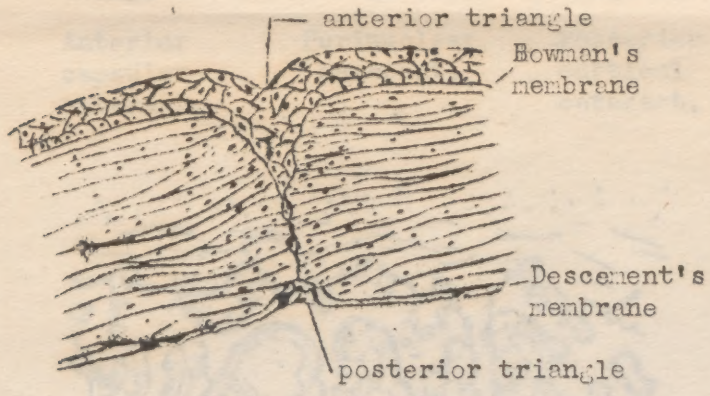


Fig. 4

Healing of a corneal wound.

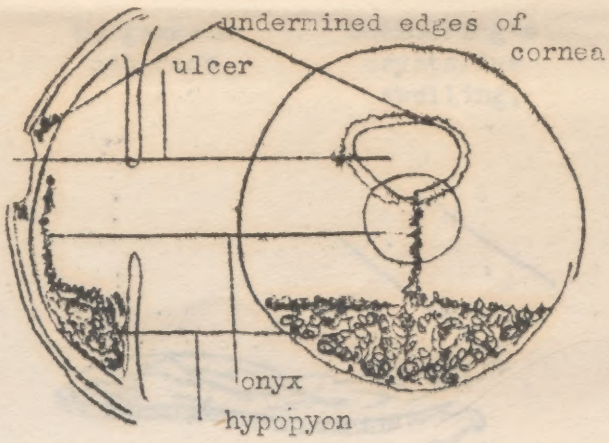


Fig. 5

Hypopyon ulcer of the cornea.

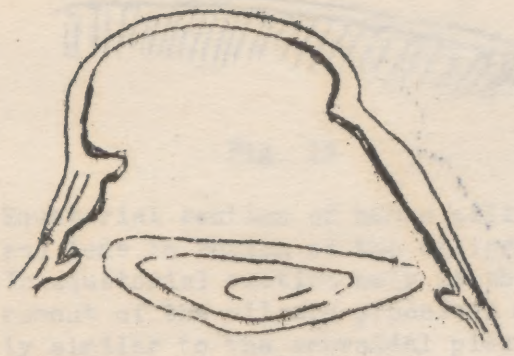


Fig. 6

Staphyloma of cornea following ulcer. Iris adherent.

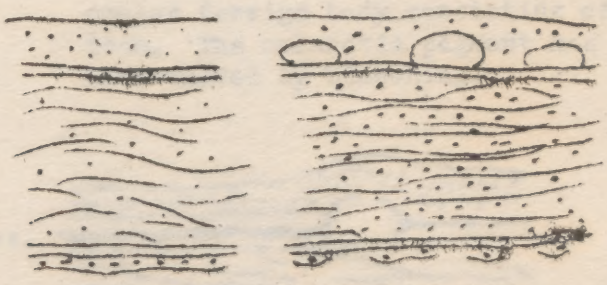


Fig. 7

Note that the endothelial is lacking in places in bullous keratitis and the stroma is more cellular.

Fig. 8

Scheme showing the direction of extension of the cells of the equatorial region as they grow to form lens fibres. The central circle shows the portion of the lens formed from the cells of the original posterior wall of the lens vesicle. (after Mann)

Diagram showing the formation of lens sutures. A, simple arrangement with no sutures. B, the "Y" suturs of the human embryonic nucleus. (after Mann)

Fig. 9

Anterior capsular cataract.

Fig. 10

Perinuclear cataract.

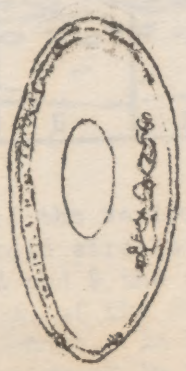


Fig. 11

Posterior cortical cataract.

Fig. 12

Morgagnean cataract.

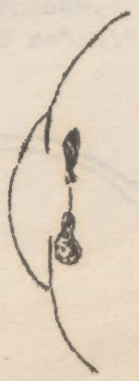


Fig. 13

Soemmering's crystaline swelling.

Fig. 14

Equatorial section of human ciliary body and lens in region of the ciliary processes. In equatorial section only is the arrangement of the ciliary processes markedly similar to the choroidal plexus of the cerebral ventricle.

Fig. 15

Iron staining of dilator pupillae due to siderosis following intraocular foreign body consisting of iron. The melanotic pigment has been removed by bleaching.

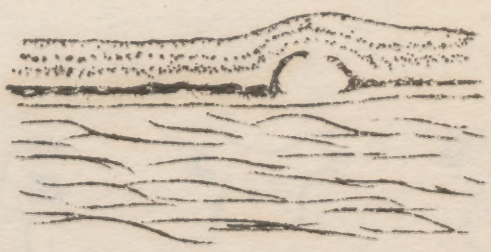


Fig. 17

Colloidal excrescence.

Fig. 16

Normal iris and ciliary body.

Atrophy of iris and ciliary body.

Fig. 23

A - Normal central retinal vessels
B - Obstruction of central retinal vein due to endophlebitis not thrombus. Results in hemorrhagic retinitis.

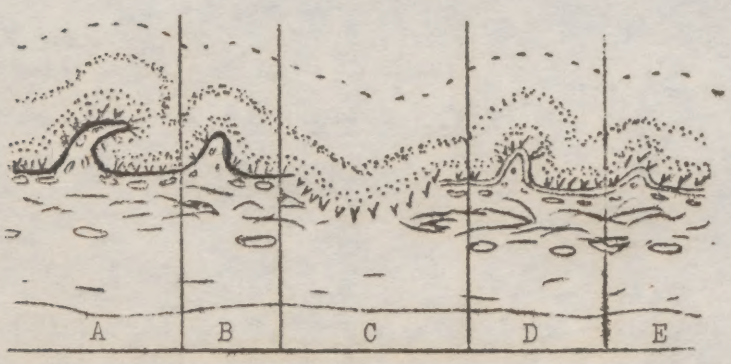


Fig. 18

A schematic representation of the various microscopic findings in angioid streaks based on Verhoeff's case. In A and B the pigment in the pigment epithelium of the retina is very great - brunet fundus. In D and E there is little or no pigment in the pigment epithelium - blonde fundus. A represents a streak bent sidewise. On the left one would be looking abliquely at the pigment epithelium. This would give the effect of looking at several layers of pigment epithelium. On the right one would be looking at three layers of pigment epithelium and two layers of the choriocapillaris. B represents a streak without a sidewise bend. C represents a tear of the choroud. D represents a piling up effect of the choriocapillaris and explains the red color of some streaks. E represents a very low streak without appreciable piling up of the choriocapillaris. Here one would see a light reflex due to a wrinkle of the retina.

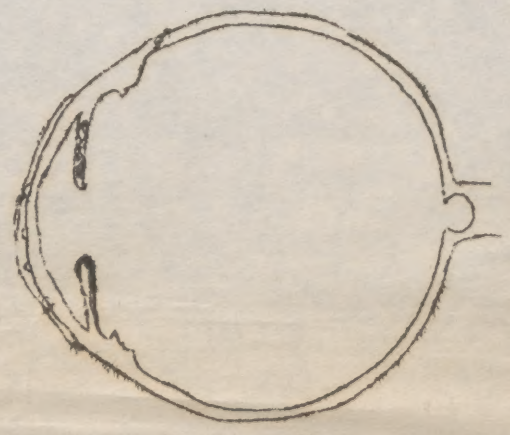


Fig. 22

Bullous keratitis, anterior peripheral synechia, fibrosis of the iris, ectropion uveae, glaucema cupping.

Fig. 19

Disciform degeneration of the macula.

Fig. 21

Nerve head in mycpia.

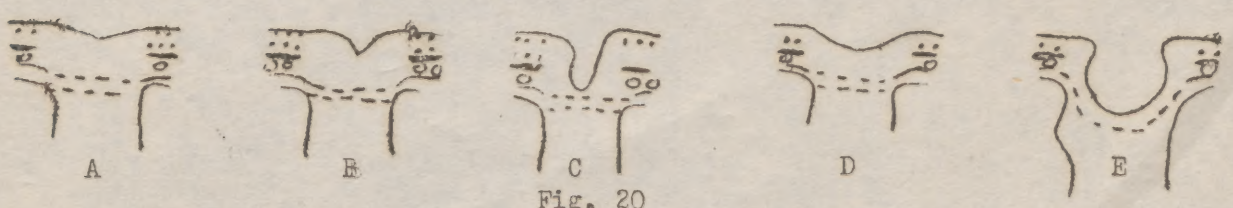


Fig. 20

A - Normal physiological cupping. B - Funnel shaped physiological cupping. C - Crater shaped physiological cupping. D - Atrophic cupping. E - Glaucoma cupping extends to the edge of the disc.

V. MacDonald, '37

Specimen V.

Brx 1173